News

FY 1984 Science Budget Overview

Astronomy, engineering, and the physical sciences as a whole were among the best funded programs in the fiscal 1984 budget that President Ronald Reagan sent to Congress last week. In addition, science education got a shot in the arm: The Reagan proposal includes plans for the nation's universities to upgrade scientific instrumentation and to attract and support high caliber scientists and engineers.

Reagan proposes that federal funding for research and development, including R&D facilities, total $47 billion in fiscal 1984, up 17% from the fiscal 1983 level. Defense research and development programs would be increased 29%; nondefense R&D would be increased 0.4%. Total basic research would be boosted 10%.

While support for science in general is strong, the budgets for the National Oceanic and Atmospheric Administration (NOAA) and the U.S. Geological Survey (USGS) have been cut, and the National Aeronautics and Space Administration (NASA) budget increase would be just short of fiscal 1984's projected 5% inflation rate. The National Science Foundation (NSF) purse, however, increases about 18% in the proposed budget.

NOAA's proposed fiscal 1984 budget is $799.8 million, down 10.4% from the current plan for fiscal 1983. (NOAA is still operating on a continuing resolution for the current fiscal year.) The main research thrust within the agency is down 9.2%. The budget proposal calls for increases to the mapping, charting, and geodesy programs and requests a research program to predict global climate anomalies based on large-scale patterns of sea surface temperature changes. Also proposed, however, are the closing the Great Lakes Environmental Laboratory and the 'deactivation' or retirement of 10 of the 22 currently available ships. Two of these ships are research vessels.

The USGS's proposed budget authority is approximately $308 million, a 7% cut from the fiscal 1983 budget plan. The agency plans to continue to expand its programs in strategic and critical minerals, acid rain, toxic wastes, and digital cartography data. A program-by-program analysis will be published in *Eos* next week.

NASA's proposed budget, coming in at $7.1 billion, shows an increase of almost 4% over the current fiscal year. Although NASA's budget boost only approaches the inflation rate, the monies will allow for modest expansion, primarily in space technology, physics and astronomy, and aeronautics research and technology. Research and development is up 3%, while the proposal for construction of facilities rises a sharp 54.4%. With Congress' nod, the budget would replace the Venus Orbiting Imaging Radar (VOIR) mission with the Venus Radar Mapper, which would cost about half as much VOIR. The Venus Radar Mapper is one of four initiatives in NASA's budget.

At NSF, research and related activities are slated to go up 17.5%. Those directorates slated for the greatest R&D increases are mathematical and physical sciences; engineering; and astronomical, atmospheric, earth, and ocean sciences. In addition, the budget proposal calls for research within the U.S. Antarctic Program to increase close to 23%. Science and engineering education activities are budgeted for a 30% increase.

The shortage of university faculty receives attention in the budget through a Presidential Young Investigator Award program. To be administered by NSF, the awards are intended to attract to university research those new Ph.D.'s who might choose nonteaching careers in industry. The fiscal 1984 proposal would support about 200 new faculty at an average of $30,000 per year for 5 years; the maximum award would be $100,000 per year for 5 years.

In addition, approximately $20 million has been allocated in the fiscal 1984 budget for improving the science and math skills of secondary school teachers.

Next week, *Eos* will publish a more detailed analysis of how the Reagan budget proposal would affect geophysicists.—*BTR*

New Computer at NCAR

Atmospheric scientists who have had to postpone analysis of their data for the lack of computer resources may not have to wait much longer. The University Corporation for Atmospheric Research (UCAR) has awarded a $4 million contract to Cray Research, Inc., for the installation of a second CRAY-1A computer system at the National Center for Atmospheric Research (NCAR). A one-million word CRAY system will be installed at the NCAR facility in Boulder, Colo., in the second quarter of 1983, according to a Cray spokesman.

'Machines of the capability of the CRAY-1 have made possible many important advances in the atmospheric sciences,' said Wilmot N. Hess, NCAR director and president of the AGU Atmospheric Sciences section. 'In the areas of climate research, oceanography, severe storms, and sun-earth relationships, both speed and memory are of critical importance. Our first CRAY-1 [purchased in 1977] opened many research doors for us and our university colleagues. The second CRAY will serve many scientists who are waiting for additional resources,' he added.

NCAR conducts research in the atmospheric sciences in conjunction with various universities. NCAR is supported by the National Science Foundation and is operated by UCAR.

IAGA News

Members of the International Association of Geomagnetism and Aeronomy (IAGA) who have moved are asked to notify the IAGA secretary general of their change of address so that their copies of the *IAGA News* can be delivered. In addition, scientists whose professional work is related to IAGA's interests and who do not already receive the newsletter should contact N. Fukushima, IAGA Secretary General, Geophysics Research Laboratory, University of Tokyo, Tokyo 113, Japan.

Geophysicists

R. H. Angerer has resigned as vice president of Geophysical Systems Corporation in Pasadena, Calif., to engage in geophysical and geological consulting as president of Integrated Exploration, Inc., in Lakewood, Colo.

Joel S. Levine, of NASA's Langley Research Center, recently was awarded the Gregory and Freda Halpern Award in Photochemistry at the 165th annual business meeting of the New York Academy of Sciences. The award is sponsored by the Polychrome Corporation. ***Riccardo Giacconi***, director of the Space Telescope Science Institute at the Johns Hopkins University, was bestowed the A. Cressy Morrison Award in Natural Sciences. At the same meeting, ***Irwin I. Shapiro***, of the Massachusetts Institute of Technology, was presented with the New York Academy of Sciences Award in Physical and Mathematical Sciences. Shapiro is an AGU Fellow. Also honored were ***Bruce Murray*** and ***Frank Press*** (*Eos*, December 28, 1982, p. 1345).

Recent staff changes at the National Science Foundation include the following appointments:

Jarvis L. Moyers to program director of the atmospheric chemistry program in the Grant Programs Section of the Division of Atmospheric Sciences.

James B. Platner to section manager, Engineering and Operations Section, Office of Scientific Ocean Drilling.

Debra S. Stokes to program associate, Submarine Geology and Geophysics Program, Ocean Sciences Research Section, Division of Ocean Sciences.

George C. Stephens, to program associate, Polar Earth Sciences Program, Polar Science Section, Division of Polar Programs.

Murli H. Manghnani has returned to the University of Hawaii in Honolulu to continue his work as a professor of geophysics. He had been the director for one year of the experimental and theoretical geophysics program within the Division of Earth Sciences at the National Science Foundation. ***Michael Mayhew*** has been appointed as Manghnani's successor.

The following AGU members were honored at the Geological Society of America (GSA) meeting in October in New Orleans: ***P. Jonathan Patchett*** of the Max Planck Institute was awarded the F. W. Clark Medal by the Geochemical Society. ***Konrad B. Krauskopf*** of Stanford University was awarded the V. M. Goldschmidt Award by the Geochemical Society. ***Eugene M. Shoemaker*** of the California Institute of Technology was awarded the GSA Day Medal. ***Robert Hazen*** of the Carnegie Institution's Geophysical Laboratory received the Mineralogical Society of America's MSA Award. ***Joseph V. Smith*** of the University of Chicago was presented with MSA's Roebling Medal.

J. Paul Riley was elected vice president of the American Water Resources Association. He is head of the hydrology and water resources division in the civil and environmental engineering department at Utah State University in Logan. ***Albert Rango*** was elected secretary of the association. Rango is head of the hydrological sciences branch at NASA's Goddard Space Flight Center.

In Memoriam

Francis W. Reichelderfer, 87, died January 26. The AGU Fellow retired as chief of the U.S. Weather Bureau in 1963; he had been appointed to the post in 1938. He joined the AGU Meteorology Section (now the Atmospheric Sciences Section) in 1939.

Request for Horton Research Grant Proposals

The American Geophysical Union is requesting proposals for the award of the ***Horton Research Grant***. The grant will be in support of research projects in hydrology and water resources by Ph.D. candidates of American institutions of higher education and will be awarded annually to a single proponent. Its objective is to foster graduate student research leading to the completion of doctoral dissertations. Proposals may be in hydrology (including its physical, chemical, or biological aspects) or in the water resource policy sciences (including economics, systems analysis, sociology, and law).

Proposals must be signed by both the student and the faculty research supervisor and must be received at the address below on or before April 1, 1983. The award will be in the amount of $4,500 and will be made directly to the winner, selected by a committee of the Hydrology section during the 1983 Spring Meeting of the Union. For a detailed description of the Grant and a guide for proposers, write to

Horton Research Grant
American Geophysical Union
2000 Florida Avenue, N.W.
Washington, D.C. 20009

Geophysical Events

This is a summary of *SEAN Bulletin*, 7(12), December 31, 1982, a publication of the Smithsonian Institution. Both the Long Valley and Earthquake reports are excerpts; the Kilauea report was published in the January 25 issue of *Eos*. The complete bulletin is available in the microfiche edition of *Eos*, as a microfiche supplement, or as a paper reprint. Subscriptions to the *SEAN Bulletin* are also available. For microfiche, order document EB83-001 at $1.00 from AGU Fulfillment, 2000 Florida Avenue, N.W., Washington, D.C. 20009. For reprints, order *SEAN Bulletin* (give dates and volume number) through AGU Separates; $3.50 for the first copy for those who do not have a deposit account; $2 for those who do; additional copies are $1.00. For a subscription, order *SEAN Bulletin* from AGU Fulfillment. The price is $18.00 for 12 monthly issues mailed to a United States address; $28 (U.S.) if mailed elsewhere. Orders must be prepaid.

Volcanic Events

Kilauea (Hawaii): Major eruption in middle of East Rift Zone.

Long Valley (California): Earthquake swarms and increased thermal activity.

El Chichón (México): No new activity; aerosol cloud continues dispersal.

Mt. St. Helens (Washington): Deformation, seismicity, and SO_2 emission quiet.

Langila (New Britain): Increasingly violent vulcanian eruptions.

Manam (Bismarck Sea): Light ashfalls; increased seismicity.

Ulawun (New Britain): Vapor emissions for 3 days.

Kusatsu-Shirane (Japan): Volcanic tremor, phreatic explosion.

Miyake-jima (Izu Is.): Earthquake sequence not volcanic.

Sakurajima (Japan): Frequent explosive activity, ash ejection; little ash.

Ruapehu (New Zealand): Moderate inflation; lake temperature lower.

Galunggung (Indonesia): Tephra ejection continues; new cone.

Iliboleng (Indonesia): Small ash eruption.

Etna (Italy): Incandescent tephra from central crater.

Costa Rica: Activity at four volcanos summarized.

Long Valley Caldera, California, USA (37.68°N, 118.86°W). All times are local (GMT−8 h). The following is from the U.S. Geological Survey.

Earthquake swarms in the Long Valley area resumed in mid-December, after quiescence that lasted through most of November. On 14 December between 0056 and 0200, 300–500 small events were recorded, of which only about 10 could be located. These were centered at 2–3 km depth in the S part of the caldera, in the Casa Diablo epicentral area of ruidy previous swarms. Spasmodic tremor (produced by a series of earthquakes that occurs too rapidly to allow clear separation into discrete events on the seismic record) was recorded for the first time since the 7–8 May swarm (see June 29, 1982, *Eos*). Increased thermal activity was noted along Hot Creek and near the epicentral area a few days before this swarm. Geyserlike activity at one Hot Creek vent occasionally elected hot water to about 10-m height, and water from

AGU to Revise Journal Index Terms

AGU is revising its set of indexing terms. If you have suggestions or comments, please contact the appropriate Journals Board member, AGU Journal Editor, or Associate Editor by February 23, 1983. AGU proposes to coordinate its index with a revision of the AIP/APS-PACS index scheme (*Phys. Rev. Lett.*, *48*, 1, 1982).

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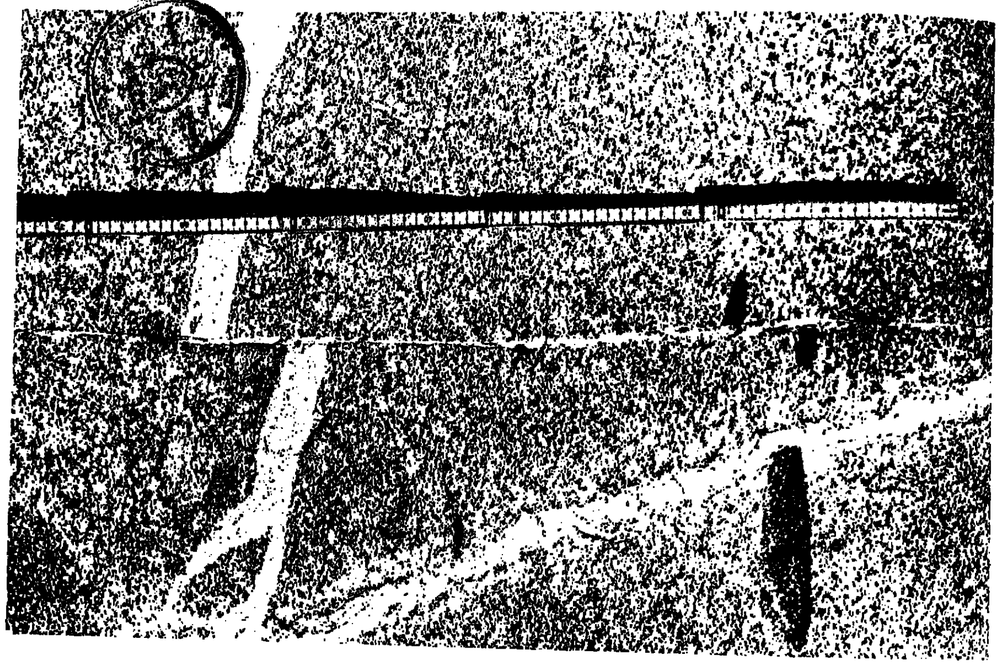

The Oceanography Report, page 42

Chemical Oceanographer. Assistant Professor, tenure track, position for applicants with recent Ph.D. and competence and interest in contemporary marine chemistry or geochemistry. Duties will include development of research projects and some teaching. Salary negotiable depending upon experience and qualifications. Submit resume and names and addresses of three references by 1 March 1983 to: G. Ross Heath, Dean, School of Oceanography, Oregon State University, Corvallis, Oregon 97331. An Affirmative Action/Equal Opportunity Employer.

Research Physicists in Ionospheric/Magnetospheric Physics. Two professional level research positions are available in the Physics Department at Boston College. Both require Ph.Ds. A research physicist will have responsibility for analysis of auroral particle data from Air Force Satellites in conjunction with present ongoing research. A background in ionospheric or magnetospheric physics is required. Previous experience with satellite data is preferred. Salary is 20–25K. A senior research physicist will have responsibility for carrying out a high energy particle data analysis program for forthcoming satellites. Extensive knowledge of the radiation belts is required, as is experience in large volume data handling and numerical modeling of high energy particles. Salary is negotiable. Please send resumes to: Prof. R. A. Chisten, Chairman, Department of Physics/MAGR, Boston College, Chestnut Hill, MA 02167.
Boston College is an affirmative action/equal opportunity employer.

Faculty Position/Princeton University Department of Geological and Geophysical Sciences. We are looking for an exceptionally creative individual in the general area of paleontology—stratigraphy—sedimentology for tenure-track appointment as Assistant Professor. Rapid increases in understanding of the processes and history of the earth's surficial environment have come about through analytical and theoretical advances in many specialties, such as magnetic stratigraphy, clay mineralogy and geochemistry, seismic stratigraphy, isotopic and microanalytical studies of fossils and sediments, sedimentation related to crustal tectonics, and mathematical analysis of stratigraphic and paleontological data. We seek candidates with strong interdisciplinary research interests in areas such as those listed, with the analytical skills and foresight to work effectively on the frontier. Within the department, the appointee should be able to take responsibility for an area such as stratigraphy, paleontology, or sedimentology, and provide a broad historical perspective. We plan to back up this appointment by our program for a general expansion of laboratory facilities, as appropriate.
Inquiries should be made to: R. A. Phinney, chairman, at the above address, or by phone, (609) 452-4100. While later applications will be considered, we would like to have them by the 31st of January, 1983, or earlier, if possible. Applicants should submit resume, names of at least three references, and a statement of research plans and interests.
Princeton University is an equal opportunity/affirmative action employer.

Faculty Position in Oceanography/University of Miami. Applications are invited for a tenure-earning faculty appointment in physical oceanography; level of appointment and salary commensurate with qualifications. Applicants should have a record of scholarly publications demonstrating the ability to interpret oceanographic observations, and several years experience in planning and execution of oceanographic field experiments. Duties include teaching graduate level courses in physical oceanography and supervising research of graduate students. Send curriculum vitae, publication list and names of three references to: Dr. Frederick Schott, Chairman, Division of Meteorology and Physical Oceanography, Rosenstiel School of Marine and Atmospheric Science, University of Miami, 4600 Rickenbacker Causeway, Miami, Florida 33149.
The University of Miami is an affirmative action/equal opportunity employer.

STUDENT OPPORTUNITIES

Graduate Scholarships in Geophysics/University of Wyoming.
Amoco and Chevron Fellowships
M.S. and Ph.D. levels
Up to $10,500/year plus tuition
Research support
Research and Teaching Assistantships
$5,500–7,200/academic year
$2,500 summer stipend
Tuition
Hill Fellowships
Variable stipends
Areas of geophysical research at Wyoming:
Reflection seismology
Gravity and magnetic potential field studies
Physical properties
Paleomagnetism and rock magnetism
Thermal processes
Crustal structure and magnetism
Tectonic modeling
Seismic data processing
Contact: Dr. Kevin P. Furlong
Dept. of Geology/Geophysics
University of Wyoming
PO Box 3006 Univ. Station
Laramie, WY 82071
307/766-4379.

Graduate Research and Teaching Assistantships in Marine Geochemistry. The Hawaii Institute of Geophysics invites applications from students interested in M.S. and Ph.D. programs in marine chemistry and geochemistry. Areas of research include marine organic and inorganic geochemistry, isotope geochemistry, sediment-seawater-organism interactions, sediment diagenesis, geochemical cycling, and tropical seawater chemistry. Current stipends are $447–576 per month for 10 or 12 month appointments. For further information, write:
Dr. K. E. Chave, Head
Marine Geochemistry Division
Hawaii Institute of Geophysics
1000 Pope Rd.
Honolulu, HI 96822.

Graduate Research Assistantships Available/Department of Meteorology, South Dakota School of Mines and Technology. Several graduate research assistantships are available beginning Fall 1983 in the areas of numerical cloud modeling, cloud physics, weather modification, radiative transfer, radar meteorology, mesometeorology, and air pollution chemistry and physics. Graduate study can lead to a Master of Science degree in Meteorology at SDSM&T as well as a Ph.D. through a cooperative program with Colorado State University. Current areas of research emphasis include 1) numerical cloud modeling at the single-cloud and mesoscale level, including 2-D and 3-D dynamics, 2) design and evaluation of field experiments and physical tools in weather modification, including hail suppression, 3) aircraft and radar investigations of cloud microphysics, 4) radiation studies of [illegible] 5) mesoscale data analysis [illegible] and 6) air pollution chemistry and physics. Applicants should have a background in [illegible] Graduate Record Examination scores should be submitted with applications. Contact Dr. Bruce L. Davis, Acting Head, Department of Meteorology, South Dakota School of Mines and Technology, Rapid City, South Dakota 57701-3995 (telephone 605/394-2291).

Graduate Research Assistantships/Cold Regions Science & Engineering. Thayer School of Engineering at Dartmouth College and the US Army Cold Regions Research & Engineering Laboratory invite applications from students interested in ME, MS, Ph.D. & DE programs with specialties in the cold regions. Potential research areas include geophysics of snow, ice & frozen ground; hydraulics and hydrology in cold regions, polar marine engineering; and materials science of ice and other frozen materials.
Undergraduate majors in engineering, physics, and geophysics are encouraged to apply. For admission requirements and more detailed information contact:
The Dean of Thayer School of Engineering
Dartmouth College
Hanover, NH 03755.

Graduate Studies in Atmospheric Sciences/Georgia Institute of Technology. Openings are available for outstanding individuals seeking a M.S. or Ph.D. degree in graduate studies in atmospheric sciences. For successful applicants, these positions include full-time research assistantships with starting salaries ranging from $8,000 to $12,500/12 months, depending on the degree being sought and the student's qualifications. All tuition and fees are covered by the Institute.
Interested students should write to:
Dr. Douglas Davis
School of Geophysical Sciences
Georgia Institute of Technology
Atlanta, GA 30332.

INSTITUTE ON FLOOD
June 27-July 1, 1983
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Special written lecture notes for practicing engineers and forecasting of floods. Well known speakers on statistics, mathematical/hydrologic/empirical methods will be described.
Lecturers:
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Institute of Conferences
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Fort Collins, CO 80523

another vent surged intermittently to about 1.5-m height.

On 21 December at 1428, two magnitude 3.3 earthquakes occurred at 6-km depth in the same epicentral area and were followed by a series of aftershocks. On 22 December, between 2140 and 2200, about 100 events were recorded outside the caldera near Red Cones, two basaltic cinder cones about 9 km SW of the 14 and 21 December epicenters. Spasmodic tremor also accompanied this brief swarm.

On 6 January, 1983, at 1623, the most intense and prolonged swarm of earthquakes since May 1980 began in the S moat of the caldera. During the first 12 hours, more than 1000 events were recorded, most in the Casa Diablo epicentral area; but with a secondary concentration near the caldera wall at Convict Creek (about 10 km to the ESE) and with many distributed between. Strong spasmodic tremor was nearly continuous during the first 12 hours. Two particularly strong shocks, of magnitudes 5.5 and 5.6 at 1758 and 1924, caused minor damage in Mammoth Lakes and disrupted electrical and telephone service for about an hour.

During the first 36 hours, earthquakes of magnitude ≥1 were occurring at a rate of 80–100/hour, those of magnitude ≥3 at 1–5/hour. During the succeeding 36 hours, the number of earthquakes gradually declined to about 15/hour. Sporadic events of magnitude 3–3.5 continued through 1200 on 10 January. As of 12 January, recorded events were continuing at a rate of 4–5/hour, still above the normal background of about 50/day. Hypocenters during the swarm ranged from 10-km to <3-km depth, with most between 4 and 7 km.

Deformation (borehole tiltmeter, dry tilt, and geodimeter) measurements made during the swarm on 10–11 January suggest that uplift of the resurgent dome accompanied the swarm, but the exact amount awaits completion of remeasurement of selected parts of the leveling network. This, together with the concentration of seismicity in the S moat and the absence of significant seismicity in the Sierra block S of the caldera during this swarm, strongly suggests that the swarm was associated with magma movement at depth. Reoccupation of the geodimeter network in early December had shown no apparent change in deformation since the previous measurements in August (see *SEAN Bulletin, 7* (8)).

Information contacts: Roy Bailey, USGS, National Center, Reston, Virginia 22092 USA; Robert Cockerham, USGS, 345 Middlefield Road, Menlo Park, California 94025 USA; Francis Riley, USGS, Water Resources Division, Stop 404, Denver Federal Center, Box 25046, Denver, Colorado 80225 USA.

Meteoritic Events

Fireballs: Australia, central Europe, Italy, Spain, New England, Oregon, and the Middle Atlantic States.

Earthquakes

Estimates of the death toll in the December 13 earthquake range from 2000 to more than 3000. About 300 villages were destroyed or damaged, and 700,000 persons were left homeless. On December 16 at least 500 were killed in Afghanistan, including six coal miners. More than 3000 were reported injured, and 7000 homes were destroyed. In Cuba, six were injured in the Havana-Matanzas-Cienfuegos area. No damage or casualties were reported on December 19; the earthquake was in open ocean in the South Fiji Basin about 770 km SSE of Fiji. The December 25 shock killed 13, injured nearly 400 (39 seriously), and damaged about 1900 homes and 120 public buildings on the eastern part of Flores. It occurred beneath Adonora Island, just east of Flores, where damage was also extensive. The December 29 earthquake in Yemen, in nearly the same place as the December 13 event, and the strongest aftershock to date, injured six and caused additional damage.

Information contacts: National Earthquake Information Service, U.S. Geological Survey, Stop 967, Denver Federal Center, Box 25046, Denver, Colorado 80225 USA; Mohammad Ali Mirza, Geological Survey of Pakistan, Quetta, Pakistan; Sanaa Domestic Radio Service, Sanaa, Yemen Arab Republic; TASS, Moscow, USSR: Karachi Domestic Radio Service, Karachi, Pakistan; Jakarta Oana Radio Service, Jakarta, Indonesia; National Broadcasting Company Television, New York, New York USA; Agence France-Presse; United Press International.

Date	Time, GMT	Magnitude	Latitude	Longitude	Depth of Focus	Region
Dec. 13	0913	6.0 M_s	14.78°N	44.29°E	10 km	Yemen Arab Republic
Dec. 16	0041	6.6 M_s	36.28°N	69.09°E	35 km	northeast Afghanistan
Dec. 16	2020	4.4 m_b	21.94°N	81.18°W	shallow	western Cuba
Dec. 19	1744	7.7 M_s	24.16°S	176.01°W	shallow	western South Pacific Ocean
Dec. 25	1228	5.6 M_s	8.49°S	123.14°E	shallow	Flores Is., Indonesia
Dec. 29	2353	5.1 M_s	14.77°N	44.36°E	10 km	Yemen Arab Republic

Books

The Spindle Stage: Principles and Practice

F. D. Bloss, Cambridge University Press, New York, xii + 340 pp., 1981, $69.95.

Reviewed by John L. Rosenfeld

When I published my first paper [*Rosenfeld, 1950*], one on what is now called the spindle stage, describing a simple device and conoscopic method for both orientation and measurement of the principal refractive indices of an optically anisotropic crystal, the existing determinative methods were clumsy, slow, and subject to error. At that time, refractive indices, inadequate though they appear in hindsight, played a large role in determining the compositions of nonopaque crystalline materials; and any improvement in optical methodology was welcome. The advent of the electron microprobe in the early sixties, capable of rapid and accurate chemical analysis, largely displaced the methods of chemical analysis relying on measurement of refractive indices. This change was reflected in many courses in optical mineralogy by deemphasis of the use of smelly and toxic refractive index liquids. The time freed was used for more intensive study of thin sections, a necessary kind of study for the formulation of petrological problems if the electron probe is to be used effectively. However, the probe did not make use of the spindle stage totally obsolete for economic reasons and because, while the probe is essentially limited to determination of elemental composition, the optical properties determined with the spindle stage reflect features of the structural state of the mineral being examined and, in many cases, the valence state of contained elements. That knowledge can be useful to the petrologist. Further, for untwinned or singly twinned crystals a well-designed and well-constructed spindle stage on a good microscope is inherently superior to the more widely used universal stage because of low cost, accuracy, simpler geometry (with consequent need for few if any corrections in its application), and much greater procedural simplicity. As an example, a reasonably skilled microscopist can use the spindle stage both to determine the composition and to discriminate among structural states for a plagioclase feldspar grain in less than a half-hour. But even for this last task, the method of the spindle stage would seem to be inferior to that of X ray diffraction with regard to structural state. Thus, in perspective, the method of the spindle stage is elegant where optical properties constitute an end in themselves, but commonly achieves only 'quick and dirty' results where petrological goals dominate. I believe the petrological literature reflects that perspective even though there are doubtless many papers that reflect elaborate and costly methods when 'quick and dirty' results would have been sufficient for the task at hand.

Placed in the above context, one may question the need for a whole book on the spindle stage. I have viewed with an increasing sense of deja vu the proliferation of papers on the spindle stage since the appearance of the still definitive paper by *Wilcox* [1959]. After that I often expressed my views to sales representatives that development of the spindle stage should have been transferred to the manufacturers of their polarizing microscopes leading to production of well-designed spindle stages, compatible with their mechanical stages (for centering and orientation), as optional equipment. Further, I pleaded that their microscopes should have been provided with 3/4 Benford plate capability to maximize their utility with the spindle stage. An opaque mask with an acentric target hole that could be inserted in the plane of the aperture diaphragm would, with appropriate eyepiece reticle, allow conoscopic use of the spindle and stage axes as a two-circle reflection goniometer, thereby expanding the utility of the polarizing microscope. I have approximated this latter arrangement, and it works!

Bloss' book should be viewed in the above perspective. The book is essentially a self-contained introductory course in optical crystallography based on the spindle stage. The book is creditably free of obvious errors. The book relies on derivative rather than primary references to a greater extent than is desirable, a common defect of textbooks in my experience. The book is well executed except for its proliferation of detail. In this day of ubiquitous pocket calculators, high page costs, and slim budgets, one may certainly question the advisability of inclusion of an eight-page table of n^{-2} (pro rata $1.85 worth of pages)! Also one may wonder whether discussion of a computer program (EXCALIBR available separately) for location of optic axes (34 p.: $7.00) is an unnecessary excrescence when simple projection techniques, also described in the book, give quick and satisfactorily accurate results at the work site.

At this time when publications must compete for the library dollar, book committees will want to reflect before including this expensive book on their purchase lists. Individual specialists whose work focuses on the optical properties of non-opaque minerals will find that Bloss has covered the existing published methodology rather thoroughly and therefore will want to purchase the book or have it available in their libraries.

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John L. Rosenfeld is with the Department of Earth and Space Sciences, University of California, Los Angeles.

Metromex: A Review and Summary

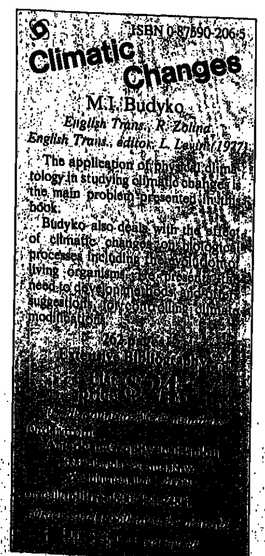
S. A. Changnon, Jr. (ed.), *Meteorol. Monogr. 18*, no. 40, American Meteorological Society, Boston, Mass., 181 pp., 1981.

Reviewed by D. Cadet

As stated in the title, this book reviews the Metropolitan Meteorological Experiment (Metromex) and summarizes the results obtained from an effort conducted over a 6-year period by several institutions. Five authors, including J. Changnon, a well-recognized expert in the field, as an editor, contributed to this monograph. The experiment was designed to know how a large metropolitan area (St. Louis) in the humid continental climate zone of the central United States affects the summer atmosphere and how these alterations change the weather and influence man. The authors can be credited in writing a complete and detailed book in which the results are presented in a very deductive manner. Each chapter begins with an abstract that summarizes the main results.

Prior to Metromex, some studies had shown urban-related influences on climate. Some of the results were questionable and emphasized the need to evaluate inadvertent modification of the weather in the assessment of the environment. This finally resulted in the design of Metromex. The last part of the introduction exposes the plans and the instrumentation.

In chapter 2 a detailed presentation of the surface weather conditions is given: temperature, humidity, winds, precipitation, and severe weather parameters. It is found that the summer rainfall increases from west to east across the city. The city is a urban-heat island characterized by a humidity deficit. Severe weather events show a maximum in the region of maximum rainfall east of the city.



The application of [illegible] climatology in studying climatic changes is the main problem presented in this book.

Budyko also deals with the effects of climatic changes on [illegible] processes including [illegible] living organisms [illegible] need to develop [illegible] suggestions [illegible] modification [illegible]

EOS

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Cover. 'Cone A' (*U.S. Geol. Surv. Bull. 1028-L*) located in the southwest region of Okmok Caldera, Umnak Island, Alaska. Eruptions at the site of this cone occurred in 1945, prompting the U.S. Geological Survey, with the encouragement of the then U.S. War Department, to initiate in 1946 its 'Alaska Volcano Investigations' Program.' In 1978, new eruptions occurred in Okmok Caldera, where a lava flow from the Cone A site extended nearly the entire length of the caldera floor. This photo was made in August 1980 during geophysical exploration work; such surveys are being conducted as part of the Geothermal Program in the Division of Geological and Geophysical Surveys of Alaska's Department of Natural Resources. (Photo made and contributed by John W. Reeder.)

ties and atmospheric sciences. Summer weather changes increase local cloudiness (10%), total rainfall (30%), and severe storm activity up to (100%). The impact on water resources is also important: more runoff (11%), more local flooding (up to 100%), and more stream and ground pollution (up to 200%). Owing to increased urban-related precipitation, an average increase of 3–4% in grain crop yields was noted as well as an increase of 100% in crop-hail losses. When all factors are considered, the impact resulting from the St. Louis area represents a net dishenefit or loss.

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Principles of Geodynamics

A. E. Scheidegger, 3rd ed., Springer-Verlag, New York, xvii + 395 pp., 1982. $75.00.

Reviewed by Paul Morgan

Twenty years ago, when the second edition of Adrian Scheidegger's *Principles of Geodynamics* was published, the study of geodynamics, the internal processes of the earth, was a specialist subject. Within a decade, new and old concepts were pulled together in the unifying working hypothesis of plate tectonics, providing a global kinematic model of the upper layer of the earth. Much remains to be learned about geodynamics, but, during the last decade, in the framework of plate tectonics, it has become a valuable tool in our understanding of most dynamic geological processes. In the preface of the third edition, Scheidegger states that, 'Although the headings of the chapters and sections are much the same as in previous editions, it will be found that most of the material is, in fact, new.' This new look at the subject is timely, because although many basic concepts of geodynamics have not changed in the past 20 years, our approach to these concepts has been radically reoriented.

The first two chapters of the text, almost one third of the book, present basic physiographic, geological, and geophysical data for the earth. In this presentation there is a liberal sprinkling of global geodynamic hypotheses, both old and new, but no coherent treatment of the data. It is unfortunate that discussion of plate tectonics does not occur until chapter 6, as many of the data presented in the first two chapters are pieces of the puzzle for which plate tectonics provides an explanation. Twenty years ago these data would have presented a stimulating challenge for discussion in a graduate seminar. Today, as an introduction to the subject, the style is rather dated. A conscious effort has been made to update the material presented, although much emphasis is still placed on older studies, almost half the references in the first chapter being pre-1963. Geodynamics has a great debt to the pioneering geologists and geophysicists, but for a reader in the 1980's, some of the concepts and hypotheses retained in Scheidegger's revision, such as the 'Tetrahedral hypothesis,' an attempt to explain the global (fixed) distribution of continents and oceans, would better have been omitted, or relegated to a chapter on historical perspectives.

Many details in the presentation and discussion of data in the first two chapters are misleading or inaccurate. For example, it is implied that all batholiths are formed by anatexis (called 'metamorphose' in the text), the distinction between fold mountains and volcano/tectonic features such as the mid-ocean ridges is not clearly made, and seamounts are described as sinking under the extra weight that they create, with no reference to thermal subsidence, probably the dominating mechanism. No reference is made to the most important geological information to be gleaned from the oceans in the last decade and a half, the results of the Deep Sea Drilling Program.

The discussion of geophysical data is disappointing. Little new work is evident in the revision of the section on seismology, and it ignores much of the new evidence for the seismic character of the Moho and layering in the crust and upper mantle that recent reflection and refraction studies have given us. A section on underground stresses, in common with many other sections, gives a summary of work in the field, but little analysis of the data or their implications. Much of the discussion of heat flow data appears to be based on a globally smoothed representation of the data set, and the approximate equality of the means of continental and oceanic heat flows is explained in terms of buried radioactivity, a concept unnecessary and incompatible with seafloor spreading. The advances of the last 2 decades of our understanding of continental and oceanic heat flow and their relationship to geodynamics are largely ignored. Similarly, the account of magnetic reversals and oceanic magnetic lineations is poor and is followed by a very short and incomplete discussion of electrical data. A brief section on geochemical data concludes the geophysical data presentation, and although this section was revised from the second edition, some statements unfortunately remain from a pre-plate tectonics understanding of the earth. In common with much of the material presented before this section, a reorganized presentation of the data in a plate tectonic framework, rather than the 'agnostic' framework from the earlier editions, would have improved these introductory chapters considerably.

Chapter 3 outlines the theory of the mechanics of deformation and, as in the previous editions, is an abrupt change in style from the data descriptions in the preceding chapters. This chapter will be difficult reading for the less mathematically inclined scholar and would perhaps have been improved by the addition of more diagrams and examples to illustrate many of the concepts defined mathematically. The chapter is long and deals with concepts ranging from simple elasticity to nonlinear creep, rheology, fracture, and attenuation, in time frames ranging from those of seismic wave transmission to isostatic rebound. Much of the material in this chapter is taken basically unchanged from the second edition of the text, with new sections added to elaborate on deformation in heterogeneous materials, fracture, and elastic parameters. A short discussion of thermal convection is given, in which it is concluded that, 'The conditions for which thermal convection may occur are extremely narrow.' This conclusion gives no hint of the importance of thermal convection in heat transfer in the earth. The content of this chapter is basically sound, but it does not contain enough detail for specialist in this field, and would be a difficult introduction to the subject for a reader with a more general interest.

Geodynamics of the earth as a planet, its shape, rotation, tides, origin, and evolution are discussed in the next two relatively short chapters. As much of the classical treatment of the earth's global properties has not been superceded in the last 20 years, only discussion of the earth's rotation and tidal effects have been significantly updated from earlier editions. The discussion of the evolution of many of the more surficial features of the earth, however, is out of date, and is again in places inaccurate. Few geologists who have studied the problems of crustal evolution in the Precambrian would agree with Scheidegger's blunt statement in this section that terrestrial plate tectonics started 'at an instant 2 × 10^9 years ago.' In a discussion of the decrease in continental heat flow with time since the last tectonic event, only the effects of erosion are mentioned, the effects of lithospheric cooling and thickening which probably dominate in extensional tectonic events are ignored. A discussion of mantle convection currents and the formation of the continental crust is very out of date. The chapter concludes with a section on historical remarks on hypotheses of earth evolution, a section that would perhaps have been better placed earlier in the text, or even omitted.

Approximately half of chapter 6, entitled 'Orogenesis,' is dedicated to the concepts and implications of plate tectonics. The remainder of the chapter discusses other, mostly older and now generally abandoned concepts and theories of orogenesis. As plate tectonics has far greater implications to geodynamics

Forum

AGU on Capitol Hill

I would like to take this opportunity to commend and thank the American Geophysical Union for supporting a Congressional Science Fellowship. This year I had my first experience with this program when the AGU Congressional Science Fellow, George Shaw, spent the year in my office. It has proven to be an exceptionally good and enlightening experience for me and my staff and, I hope, for him as well.

I must admit I was skeptical as to the value of having a scientist in the office for a year, a skepticism which I suspect would likely be shared by most Members of Congress who tend to be steeped in the humanities or, worse, the law. That skepticism, I think, grows out of a prejudice: that scientists are both too clinical and too "ivory tower" to function well in the visceral and rough and tumble world of political policy making.

Today, I know that is pure bunk.

Value of the Science Fellow

I am very glad that I "hired" a science fellow. I've learned many things about science and scientists and have a much better appreciation for the significant potential impact of science and technology on public policy.

Further, I am now convinced of the need for more technically trained people in the Congressional legislative process. While the Committee staffs often boast very capable scientists, it is extremely rare to find technically or scientifically trained people on the personal staffs of members who, in fact, deal with technical issues all the time. Because Congressional staff work involves—as does graduate school—long hours, lots of work, and low pay, the individual Member of Congress seldom has the ability to hire people with a natured scientific background. This is unfortunate and the process suffers for it.

However, in addition to being a member of the House Energy and Commerce Committee which deals with many technical issues all the time, I'm a member of the House Administration Committee. In that capacity I will have a chance to raise the issue of staffing in Congressional offices as it relates to the need for technically trained staff. I imagine that, to date, relatively few members realize the degree to which staff members with a science or technical background could improve the overall effectiveness of their offices.

AGU's Contribution

AGU's Congressional Science Fellowship program serves a very useful purpose in making Members of Congress more aware of the contributions scientists can make in the legislative process. Beyond that, it also serves to demonstrate that scientists, just like lawyers, journalists, businessmen, farmers, and all the rest, can function very effectively in a political arena.

The political process will be much better off when we develop a keener understanding of the utility of technical information to us and as we understand that the scientist, too, can be politically savvy. When that is understood there will be a much greater likelihood that science will become better integrated in the decision making process than it is today.

I would not want to ignore, either, the fact that the scientist no doubt develops a better understanding of the legislative process. Taking that knowledge back into the scientific communities pays dividends as well, I'm sure.

AGU's Congressional Science Fellowship program is an excellent means of accomplishing these goals. It fills an immediate need for technical information, as well, which in my case bore directly on such issues as the Clean Air Act rewrite, sound nuclear waste disposal legislation, and the Alaska Natural Gas Transportation System, among others.

I personally hope that another Science Fellow will decide to spend next year in my office, providing the kind of expertise that I never had before and which, I'm afraid, I have come to depend on. Congratulations on your excellent program.

Al Swift
Member of Congress

A Footnote

In most of my discussions with colleagues and others since returning from a year as the AGU Congressional Science Fellow, I have been asked "What is Congress really like?" The question always carries the implication that I should be able to reveal the seamy, inside dope on what a corrupt institution it is. Two years ago I probably would have asked the same question, with the same implied cynicism.

Fortunately, Congress is a far better institution than the public thinks it is, and Congressman in general are far better than they get credit for. In fact I am convinced that Congress is the most underrated institution in the country. Members of Congress (M.C.'s) and Senators are better informed and brighter than the average. They work harder and under more difficult conditions than most people. And they are dedicated to doing a good job.

If that is so, what is the origin of the general discontent with Congress? I don't have enough space or time to deal with that question exhaustively, but I will cover a few points. I do this because those of us with information to convey to Congress will do a better job if we have a more accurate perception of its members and a better appreciation of the problems they face. Cynically dismissing Congress as a bunch of venal incompetents will accomplish nothing. I offer three areas in which general perceptions are inaccurate.

General Misperceptions

First, poll results indicate that by 3 to 1 voters rate Congress negatively but by a similar margin rate their own Congressman positively. Why the disparity? At the risk of stating the obvious, this is simply the result of representative democracy in a complex, pluralistic society. Your M.C. and Senators vote their constituency most of the time. But there are 434 other congressional districts and 49 other states with different makeups, and what is perceived to be in the 'national interest' in one part of the country clearly is often not perceived that way somewhere else. Your own representatives look good fighting for what you want against the interest of those bad actors in Congress who want something different.

Second, we elect representatives to resolve issues through compromise and bargaining; the issues are tough and the compromises, however necessary, satisfy very few. Two hundred twenty million people cannot make the necessary bargains and tradeoffs on national issues. We ask Congress to do that. Then, naturally, we complain about the results. But we are too complain about the process: vote trading, log-rolling, cutting deals, etc., all have negative connotations with the public. We crucify our representatives for one wrong vote, without asking or even caring why that vote was necessary or what trades were made. And if we do find out, we protest bitterly about the seaminess of trading votes. How else, may I ask, are the compromises to be reached? I have observed Congressmen who are uncompromising. They don't get much from their colleagues except scorn. "If you're not willing to move in my direction, I'll find someone else who will." Conflicts cannot be resolved (short of violence) unless people have the flexibility to bargain, and for Congress that means vote trading, log-rolling, etc.

Third, a common complaint these days is that Congress doesn't *do* anything. (There are those who rejoice in that!) This is more an inability to act than a desire not to, and the problem, I believe, real. What is the problem? Surely there are enough critical issues to warrant Congressional action. The main source of this problem is that Congress so accurately reflects the public mood. Today our society is highly polarized by a number of issues which have a high emotional content and which result in an either-or attitude. We have elected representatives who reflect our attitudes. They tend to be uncompromising, combative—and popular. This leads to a legislative situation which is more common now than it has been in the past—two strong, highly polarized factions and a small, weak middle ground. Since the middle is small and carries the swing votes, it is to the benefit of the two sides to pick away at these middle votes without compromising significantly. On any given issue, one side or the other may be successful at piecing together a bare majority, but with the expenditure of an enormous amount of time and energy, only to have the issue reversed by the slightest shift in votes at some later time. This often results essentially in no real decision. Neither side will compromise because they perceive their own strength as large enough to prevail if only they can get a little piece of the center, and they perceive their positions to be pure, correct, and not to be compromised. The art of compromise is not dead, but it's certainly in bad shape.

Dangers of Extremism

This country faces a number of serious problems, many of which have a high scientific and technical content. As scientists and citizens we want these problems resolved with maximum awareness of the technical aspects. If we are going to make a contribution, we must have as clear and undistorted a view of the decision making process as we can possibly get. We can expect to influence the process if we are sensitive to the difficulties of our representatives and if we become more politically aware. We cannot expect that the chosen solutions to problems will be technically perfect. We do not, thank goodness, live in a technocracy. My own state representative (who is a scientist) once told me (approximately), "You geologists amaze me when you treat this issue as if it should be resolved on a technical basis. You do realize that it's actually going to be political." That is true, of course. Our job is to get the greatest possible degree of congruence between scientific and political reality. Our society will reflect our success or failure.

Finally, I regard today's polarized political environment as unhealthy and a threat to our ability to resolve our problems. We must back off from polarized confrontations and reinvigorate the center. I am surprised, I confess, to find myself taking this position, but I have seen confrontational politics at work. It makes great theater, but it doesn't get the job done. The election of more moderate representatives will improve the health of the body politic. Those groups (and I believe scientists qualify) who are accustomed to rational, balanced analysis in examining available information can help considerably to moderate the political climate, but only if they become more aware of the political process and get more involved in it.

George Shaw
University of Minnesota

than just orogenesis, it is unfortunate that it was not treated in a separate chapter, rather than being squeezed into the basic format of the pre-plate tectonics editions of the text. The use of pre-plate tectonics terminology and concepts makes the discussion of plate tectonics rather weak and in places somewhat misleading. Mid-ocean ridges are described as 'oceanic orogenesis,' a term that incorrectly implies major deformation in these volcano/tectonic features. Geosynclines are described in a classical geological sense, where a more modern geodynamic approach would be to discuss the developments of the past decade or so in understanding the flexural, thermal, and tectonic factors in basin formation. Calculations of volume relationships in orogenesis do not account for the fundamental differences in the mechanisms of formation of mid-ocean ridges and fold mountain belts. A section on the theory of plate motions is rather shorter than would be expected for what may be considered as the fundamental of all terrestrial geodynamic processes. Scheidegger expresses a valid distaste for the number of assumptions required to model these processes, but is distastespring the issue by his superficial treatment of these processes. In contrast, his treatment of other theories of orogenesis is given more emphasis than is probably justified.

The last two chapters of the book deal with the local application of geodynamics, primarily material usually described as structural geology. These two chapters are the best part of the book and present a reasonable overview of geodynamic processes on a local scale. Extensive reference lists are given in many of the sections, and large parts of these chapters show thorough and timely revisions from the earlier editions of the text. Chapter 7 discusses features associated with the regional stress field, and chapter 8 with local instability phenomena, the theory of volcanic and impact features, and measurable vertical and horizontal crustal displacements. Most of the material in these two chapters is not treated in detail, but with the reference lists make a good starting point for more detailed studies.

Almost 30 years has passed since Adrian Scheidegger wrote the first edition of this book, and he has made a valiant effort to revise the third edition to acknowledge the fundamental advances in the subject of the last 2 decades. Unfortunately, I feel that for much of the book, particularly for the global aspects of geodynamics, he would have done better to reorganize completely the framework of his text or to make a fresh start. Scheidegger's style is at times rather stilted and is difficult to follow, especially when the discussion makes reference back and forth to earlier and later sections of the text. As in previous editions of this book, references are given as footnotes, which results in much repetition of the references and the loss of a comprehensive reference list. Adequate author and subject indexes provide a reasonable substitute for this list, however. Many references are in the non-English literature, which will limit their use as a source of further information for many readers. Understandably, Scheidegger references his own work extensively, although in some instances, for example, in the discussion of fault plane solutions, more lucid works have been published which would have made better references. I noted few typographical errors in the text, most of which were in the footnotes and were minor, but occasional discrepancies between the text and figures and undefined or remotely defined symbols in equations were more annoying.

The timing for publication of a good text on geodynamics is excellent. Unfortunately it is unlikely that *Principles of Geodynamics* will fill the need for such a text. Different chapters of the book are written at different levels ranging from introductory to senior/graduate, and, thus, even without its other faults, it would not make a good teaching text. At least two other texts have been published this year (1982) which give a more modern treatment of similar subject matter, and at $75 it is unlikely that Scheidegger's text will fit into the personal budgets of most researchers in this field. Adrian Scheidegger has made many valuable contributions to both geodynamics and geomorphology, but it is with regret that I cannot recommend the third edition of *Principles of Geodynamics* as a good modern text on geodynamics.

Paul Morgan is with the Lunar and Planetary Institute, Houston, Texas.

Proceedings of the Third Symposium on Polar Meteorology and Glaciology

K. Kusunoki (ed.), *Mem. Nat. Inst. of Polar Res.*, Spec. Issue, vol. 19, National Institute of Polar Research, Tokyo, Japan, iv + 320 pp., 1981.

Reviewed by Takeshi Ohtake

The symposium was held on January 13–14, 1981, at the National Institute of Polar Research in Tokyo. The proceedings consist of 20 research papers. The papers are further divided into major groups of POLEX-South, POLEX-North, Antarctic aerosols, Antarctic precipitation physics, Lidar observation, atmospheric circulation, oxygen isotopes, and glaciological studies in the Antarctica.

The first seven papers report the meteorological observations at Syowa Station (69°00'S, 39°35'E) and Mizuho Station (70°42'S, 40°20'E, 2230 m MSL, 270 km inland from Syowa Station). Two papers by Yamanouchi et al. are concerned with radiometric measurements at Syowa and column water vapor amount at Mizuho. The total precipitable water at Mizuho in summer was 0.15 g/cm^2, and some diurnal variations were observed. The seven papers mainly describe the methods and preliminary results of meteorological observations as related to the POLEX-South project. Further interpretation, statistics, and discussions of the results are left for the future. The purpose of the observations aims at studying the heat budget of the eastern Antarctica.

The paper by Higuchi outlines the observations of Arctic clouds and precipitations conducted in northern Canada in the winter of 1979–1980. The observations include fine structure of precipitating winter clouds by 8.6 mm vertically pointing radar, distribution, and change of precipitating clouds, using 3.2 cm short-range PPI radar and types and numbers of snow crystals as well as sampling of new snow for measurements of oxygen isotopes and trace elements. The study of radars describes the relationship between radar echoes, ice crystals, and temperature profile of the atmosphere. The paper also reports differences between the levels of cloud top (defined from humidity more than 90% R.H. wrw) and radar echo tops. The oxygen isotope study tends to determine the formation temperature range of snow. Yamamoto and Iwashima studied the variability of the Arctic temperature field as one of the most sensitive indicators of climatic changes and atmospheric CO_2. Numerical simulation of Arctic stratus clouds is reported by Ohta. The paper claims that the stratus clouds are generated by cooling of warm moist air advected over the polar ice. After the clouds formed at a height of 70 m because of lowering sea surface temperature, more condensation of water vapor took place at the cloud top due to intense radiative cooling. Since the surface temperature remains at a constant value, lowering of cloud temperature results in an unstable condition of the atmosphere below the clouds. This causes the transport of water vapor from the melting ice surface and accelerates the condensation. Another numerical simulation on Fourier filtering in a barotropic Arctic ocean model was made based on the vorticity equation by Sasaki and Imawaki. The study related to the general circulation patterns, i.e., global climatic changes. Takano explored a possible effect of the isentropic mixing on the formation of the Antarctic bottom water by using a numerical model of oceanic general circulation.

The composition and origin of aerosols at Syowa are reported by Iwai et al. Most particles in winter (larger than 0.4 μm diameter) were identified as sea salt, while those in summer were considered to be Ammonium sulfate. The paper by Koide et al., however, found the particles were mainly sea salt in all seasons by using neutron activation chemical analysis. The weight ratio Cl/Na for giant particles was larger than the bulk sea water ratio. On the other hand, Ono et al. reported that the high concentration of aerosols (smaller than above but larger than 0.004 μm diameter) was not associated with high surface ozone value, i.e., not attributed to stratospheric sources. Aerosol generation by photochemical reaction in the Antarctic summer is suggested.

Iwai reports the frozen small raindrops of drizzle size at Syowa, which are considered to be produced by a coalescence and subsequent freezing of supercooled droplets. Kikuchi et al. made observations of precipitation intensity of snow crystals which were replicated by formvar solution. The intensities were determined by conventional empirical formulae as indicated by relations between size and mass of snow crystals.

To investigate polar stratospheric aerosols and ionospheric phenomena in the middle-upper atmosphere (10–120 km), a laser radar is to be installed in Syowa. Iwasaka et al. made preliminary observations with it at Nagoya, Japan, and successfully detected the volcanic aerosols from Mt. St. Helens several days after its eruption. The greatest observational effort by using the laser radar will be focused on aerosol transformations of sulfuric acid to ammonium sulfate in the polar atmosphere. Iwasaka made a numerical estimation of stratospheric water vapor budget on a global scale through ice crystal growth in the polar winter atmosphere. Iwasaka et al. describe a preliminary experiment to utilize the technique of Lymanalpha line absorption to monitor a trace amount of water vapor in the polar middle atmosphere by an aircraft or balloons.

Nakajima et al. compared meteorological conditions at Mizuho with those at Syowa. The summer at both stations is characteristically less disturbed, while winter days are dominated by disturbances every 7–15 days. Yasunari has shown a predominant periodicity of 30–40 days of cloudiness fluctuation over India during the northern summer monsoon period. This periodicity is triggered by a cold air outbreak toward the equator, associated with a westerly wave motion in the southern hemisphere. Such periodic fluctuations are found even at the 500 mbar level of Syowa. It is striking to know that the Asian summer monsoon is closely related with the hemispheric-scale wave motions in the southern hemisphere.

The article of Kato describes the production rates of ^{14}C and ^{32}Si in the atmosphere in the Maunder Minimum period (=Little Ice Age) (A.D. 1645–1717) related to the climatic change. Although the records of ^{14}C concentration (by Eddy) agree to the date of the cold event, ^{32}Si do not agree with the date. The paper discusses the cause of the discrepancy. The Kato and Watanabe paper discusses the way to obtain paleoclimatic information from the oxygen isotope data using the ice core sampled at Mizuho.

Araoka and Maenos' paper related to saltating (=leaping) of blowing snow particles. Trajectories, fall velocities, and accelerations of flying snow particles were obtained by photographs. Watanabe and Kato analyzed oxygen isotope and snow stratigraphy of 2 m deep pits and 10 m deep cores sampled from the coast to Mizuho. They obtained a seasonal diagram of oxygen isotope values of snow as a function of the elevations. From the study they are attempting to find a correlation between oxygen isotope values and the glaciological environment. It seems elaborative work. Fujii observed snow surface conditions for the entire year of 1977 at Mizuho, which had snowfalls, sublimation, condensation, and blowing snow. He found the mean annual balance of snow accumulation for 4 years was between 1.5 and 14.8 cm. A model of transmigration of surface condition is proposed. Another of Fujii's papers discusses seminannual variation of microparticle concentration in snow collected at Mizuho. The regional distribution of surface mass balance in Mizuho Plateau is reported by Yamada and Wakahama based on the data accumulated for 10 years.

Takeshi Ohtake is with the Geophysical Institute, University of Alaska, Fairbanks, Alaska.

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POSITIONS AVAILABLE

Research/Senior Research Associate in Planetary Geology. A position is open for a planetary geologist/geophysicist at the Lunar and Planetary Laboratory, University of Arizona. The applicant should have a Ph.D. in geology or geophysics and research experience in impact cratering, including cratering mechanics and the planetary cratering record. A resume and three letters of reference should be sent to: Robert G. Strom, Lunar and Planetary Laboratory, University of Arizona, Tucson, AZ 85721.

The University of Arizona is an equal opportunity employer.

Geophysicist/University of Montana. The Geology Department of the University of Montana is inviting applications to fill a tenure track position at the assistant or associate professor level with a specialized area of geophysics beginning Sept. 1985. Teaching and research responsibilities at the undergraduate and graduate levels. Research interests should combine solid earth geophysics and geology.

Applicant must have the Ph.D. degree or expect completion by summer of 1983. Those interested should send a letter of application, resume, an outline of teaching and research interests and other relevant material. The applicants should arrange to have at least three letters of recommendation sent to: Arnold J. Silverman, Chairman, Department of Geology, University of Montana, Missoula, MT 59812.

The deadline for applications is March 15, 1983.

The University of Montana is an affirmative action/equal opportunity employer.

Franklin and Marshall College/Petrologist. We have a 1-year position for the 1983–84 academic year with the possibility that the position may be extended for 1 additional year. The position is full-time involving up to 12 contact hours/semester. Candidates would teach petrology (a one-semester combined igneous and metamorphic course) and either economic geology or a course in their specialty. Candidates would also teach introductory physical geology once a year. Completion of Ph.D. prior to appointment is preferred but not essential.

Franklin and Marshall College has an active geology department which consists of 7 full-time staff members and graduates 25 majors per year. Teaching and research facilities are excellent including an automated NRF vacuum spectrometer. The college is a small (2000 students) four year liberal arts institution.

Candidates should send resume and arrange for 3 letters of reference and transcripts to be sent to:

Dr. Stanley A. Mertzman, Chairman
Department of Geology
Franklin and Marshall College
P.O. Box 3003
Lancaster, PA 17604.

Franklin and Marshall College is an equal opportunity employer.

Chemical Oceanographer. Assistant Professor, tenure track position for applicants with recent Ph.D. and competence and interest in contemporary marine chemistry or geochemistry. Duties will include development of research projects and some teaching. Salary negotiable depending upon experience and qualifications. Submit resume and names and addresses of three references by 1 March 1983 to: G. Ross Heath, Dean, School of Oceanography, Oregon State University, Corvallis, Oregon 97331.

An Affirmative Action/Equal Opportunity Employer.

Assistant Research Oceanographer/SIO. The Ocean Research Division of Scripps Institution of Oceanography invites physical oceanographers to apply for a position as Assistant Research Oceanographer, the research equivalent of Assistant Professor (Ph.D. in physical sciences or equivalent degree required). Candidate must have strong background in applied mathematics and fluid dynamics; strong interest in ocean dynamics; and proven research and publication record in physical oceanography. This position is funded through ONR contract for two years. Appointment beyond two years is contingent on candidate obtaining extramural support. It is expected that the majority of research effort during the two years will be devoted to the theory and analysis of data on Kuroshio variability. Salary range is $22,900–$26,800 commensurate on qualifications. Position start date is approximately 4/1/83. Please send resume and at least three references to Dr. Russ Davis, Chairman, Ocean Research Division A030, Scripps Institution of Oceanography (Ex La Jolla, CA 92093 by March 15, 1983. For additional information about the position contact Dr. Peter Niller (619) 452-4100. The University of California, San Diego is an Equal Opportunity/Affirmative Action Employer."

Assistant or Associate Professor/CSM. The Geology Department of the Colorado School of Mines invites applications for a faculty position commencing September 1, 1983 as Assistant or Associate Professor of Geology in the specialty of Paleontology and Sedimentary Geology to teach courses at the undergraduate and graduate levels, direct theses and conduct research in these areas. The Ph.D. degree is required. Salary is dependent upon experience.

The deadline for applications is April 15, 1983. Resumes and references should be mailed to: Dr. J. J. Finney, Head, Geology Department; Colorado School of Mines; Golden, Colorado 80401.

Colorado School of Mines is an Affirmative Action, Equal Opportunity Employer.

Atmospheric Chemistry & Aeronomy Division (ACAD) and Scientific Computing Division (SCD)/ Ph.D. Scientist I or II. The National Center for Atmospheric Research in Boulder, CO is seeking a scientist to establish and manage the scientific research program of the ionosphere, magnetosphere, and atmosphere. Demonstrated high level of skills in advanced FORTRAN programming, numerical modeling data reduction techniques (level III) required; national scientific recognition and demonstrated leadership skills in and promoting Incoherent Scatter Radar research. This is a term position subject to annual review and continued funding for project. Send resume PROSPECTUS to Esther Blount, NCAR, P.O. Box 3000, Boulder, CO 80307 or call 303-494-5151 ext. 581 for information.

NCAR is an equal opportunity/affirmative action employer

Naval Postgraduate School. The Department of Oceanography invites applications for the position of Adjunct Research Professor in the Ocean Turbulence Laboratory. The successful applicant will be responsible for the organization and execution of oceanic turbulence measurements as well as the interpretation and reporting of the obtained data. The position requires a Ph.D. or equivalent in Physical Oceanography, 3 years of post-doctoral experience with oceanic measurements and data interpretation, and some familiarity with turbulence instrumentation. The Ocean Turbulence Laboratory is actively engaged in the measurement and interpretation of oceanic turbulence data from a variety of environments obtained with several type of vehicles. The successful candidate will be expected to contribute to the growth and development of the scope of the research performed by the laboratory.

Applicants should send a resume, statement of research record and interests, and the names of at least three references to, Prof. Thomas R. Osborn, Code 68Or, Naval Postgraduate School, Monterey, CA 93940.

Applications will be considered until March 8, 1983. Applicants should provide a curriculum vitae, three professional references, and a statement of professional (research and instructional) goals: Send letters of application to: Professor Christopher N. K. Mooers, Chairman, Department of Oceanography, Naval Postgraduate School, Monterey, CA 93940. Phone: (408) 646-2562/2555.

An Equal Opportunity/Affirmative Action Employer.

Faculty Position/Princeton University Department of Geological and Geophysical Sciences. We are looking for an exceptionally creative individual in the general area of paleontology—stratigraphy—sedimentology for tenure-track appointment as Assistant Professor. Rapid increases in understanding of the processes and history of the earth's surficial environment have come about through analytical and theoretical advances in many specialties, such as magnetic stratigraphy, clay mineralogy and geochemistry, seismic stratigraphy, isotopic and microanalytical studies of fossils and sediments, sedimentation related to crustal tectonics, and mathematical analysis of stratigraphic and paleontological data. We seek candidates with strong interdisciplinary research interests in areas such as those listed, with the analytical skills and foresight to work effectively on the frontier. Within the department, the appointee should be able to take responsibility for an area such as stratigraphy-paleontology, or sedimentology, and provide a broad historical perspective. We plan to back up this appointment by our program for a general expansion of laboratory facilities, as appropriate.

Inquiries should be made to: R. A. Phinney, chairman, at the above address, or by phone, (609) 452-4100. While later applications will be considered, we would like to have them by the 31st of January, 1983, or earlier, if possible. Applicants should submit: resume, names of at least three references, and a statement of research plans and priorities.

Princeton University is an equal opportunity affirmative action employer.

Iowa State University of Science and Technology, Department of Earth Sciences/Faculty Position. Applications are invited for a tenure-track faculty position in mineral resources. Rank is at the assistant or associate professor level, dependent upon qualifications. The successful applicant will be expected to develop a strong research and graduate student program in mineral resources/economic geology and will teach undergraduate and graduate courses in this subject. An applied field orientation is preferred.

Iowa State has established a Mining and Mineral Resources Research Institute in order to support and develop research and education in mineral resources. An interdepartmental graduate minor in Mineral Resources has also been established. In addition to the appointment in the Department of Earth Sciences, there will be full opportunities to interact with these programs.

Completion of the Ph.D. prior to appointment is strongly preferred. In addition, research ability shown by other publications and/or postdoctoral or industrial experience will be an advantage. The position is currently available and is expected to begin no later than September 1983. For application information, please write to:

Bert E. Nordlie, Chairman
Department of Earth Sciences
253 Science I
Iowa State University
Ames, Iowa 50011

Iowa State University is an equal opportunity/affirmative action employer

Marine Geophysicist/Texas A&M University. The Department of Oceanography of Texas A&M University will have an opening for a tenure track faculty member in Marine Geophysics beginning September 1983. Preference will be given to candidates with a strong quantitative background in a wide range of geophysical topics and who have both interest and experience in marine exploration.

The successful applicant will be expected to teach undergraduate and graduate courses and to conduct a vigorous research program in his or her specialty. The position is to be filled at the level of Assistant Professor. A Ph.D. is required for this position. Salary is negotiable depending upon experience and qualifications.

Applicants should submit a vita along with a letter describing his/her research and teaching goals and names of five persons for reference to Professor R. O. Reid, Head, Department of Oceanography, Texas A&M University, College Station, TX 77843. The closing date for applications is March 15, 1983.

Texas A&M University is an affirmative action/equal opportunity employer.

Postdoctoral Research Associate Mineralogy. Applications are invited for research in high-resolution and analytical transmission electron microscopy of minerals and their analogues. Experience in crystallography, materials sciences, or electron microscopy is desirable. Send resume (including transcripts), statement of research interests, and names of three references to Dr. P. R. Buseck, Department of Geology, Arizona State University, Tempe, AZ 85287. ASU is an EO/AA employer.

AMOCO Foundation Ph.D. Fellowship

Department of Geology University of Missouri-Columbia

The Department of Geology invites applications for the Amoco Foundation Fellowship to support an outstanding Ph.D. Candidate in any subdiscipline of geology. This 3-year fellowship includes a generous stipend, waiver of tuition and fees, and substantial funding to support research. The Department of Geology has dynamic research programs in sedimentology, sedimentary petrology, low temperature geochemistry, tectonics, geophysics, paleontology, and igneous and metamorphic petrology.

For application materials and additional information contact:

Director of Graduate Studies
Department of Geology
University of Missouri-Columbia
Columbia, MO 65211

The deadline for application is March 1, 1983.

Geophysicists/Institute for Geophysics, University of Texas at Austin. Applications are invited for research scientists with a Ph.D. in the general areas of marine geophysics or theoretical seismology. We are particularly interested in innovative individuals who wish to pursue a career primarily in research with some teaching and graduate student responsibilities. The Institute is located in Austin and operates closely with the Department of Geological Sciences of the University. It is a vigorous and growing group with interests in both land and marine geophysics. Research facilities include a 167' ship equipped with state-of-the-art multichannel and high resolution seismic reflection and GHN seismic refraction capabilities.

Applicants should have a demonstrated ability to do creative research. Both mid-career and recent Ph.Ds are encouraged to apply. Applicants should submit resume, the names of at least three references and a statement of research plans and priorities to:

A. E. Maxwell, Director
Institute of Geophysics
University of Texas at Austin
Austin, TX 78712.

While late applicants will be considered, we prefer to have applications in hand by April 15, 1983.

The University of Texas is an equal opportunity/affirmative action employer.

Isotope Geologist/University of Wyoming. The Department of Geology/Geophysics invites applications for a tenure track position at the assistant professor level in isotope geology. The applicant's field of specialty may be stable or radiogenic isotopes. The successful candidate will be expected to teach undergraduate and graduate courses and conduct his/her own research program.

Current research at the University of Wyoming includes: crustal evolution in the Archean and Proterozoic; the systematics of magma contamination; carbonate diagenesis; fluid-rock interaction; and the tectonic evolution of compressional and extensional orogenic belts. We hope the successful candidate will complement these studies as well as develop a strong, independent program. Applicants should submit a vita, transcripts, a letter describing future research interests, and names of three references to Dr. Robert S. Houston, Head, Dept. of Geology/Geophysics, PO Box 3006, University Station, University of Wyoming, Laramie, WY 82071. Closing date for applications is February 28, 1983.

The University of Wyoming is an equal opportunity/affirmative action employer.

UNIVERSITY OF CAPE TOWN

Chamber of Mines Chair in Geochemistry

Applications are invited for the above post for appointment on or as soon as possible after 1 January 1984.

The University wishes to appoint an outstanding geochemist of international stature in succession to Professor L H Ahrens, the previous incumbent of the Chamber of Mines Chair in Geochemistry. Applications are invited from geochemists with research experience and interests in any field of geochemistry. An exceptional research record and the proven ability to provide scientific leadership of the highest calibre will be the most important criteria by which candidates will be evaluated.

The post is for permanent appointment subject to a three-year probationary period. Appointment will be made according to qualifications and experience on the salary range R23 109 to R30 225 per annum.

Applicants should submit a full resumé and the names and addresses of three referees, whom the University may approach.

Further information may be obtained from the Registrar (Attention: Appointments Office), University of Cape Town, Private Bag, Rondebosch, 7700, South Africa, by whom applications (quoting ref no. 84/311) must be received not later than 30 June 1983.

UCT is an equal opportunity employer.

SENIOR RESEARCH SCIENTIST/TRAINING MANAGEMENT POSITION
International Ground Water Modeling Center

A position will become available July 1, 1983 for a Senior Geohydrologist to direct the International Ground Water Modeling Center (IGWMC) at Butler University's Holcomb Research Institute in Indianapolis, Indiana, USA. The IGWMC is an international information and training center for ground-water modeling which conducts a program in applied research on ground water modeling, organizes an annual series of short courses, provides assistance in workshops and seminars, operates a clearinghouse for ground water models, and publishes the Ground Water Modeling Newsletter. Negotiations are currently underway to initiate IGWMC activities in cooperation with the Dutch research organization TNO by opening an office in Delft, The Netherlands, in late 1983. An international policy group, assisted by an international advisory committee, provides oversight to IGWMC.

The successful applicant will have a background in ground water hydrology preferably at the Ph.D. level. He or she must possess a minimum of five years experience in conducting studies of quantity and quality of ground water resources and should be acquainted with theory and application of modern ground water modeling techniques. Experience in project management and training/education is preferred.

As the senior management person in the HRI-IGWMC office, the incumbent will manage the daily activities of the Indianapolis office of IGWMC. Major duties of the position include planning and implementing IGWMC activities in the North, Central and South American region, facilitating information tasks of the center, which include initializing and maintaining contacts with ground water modelers, researchers, field technicians and water resources managers. Incumbent will also provide oversight of and participation in the Center's training programs and all technical tasks for the Center. Person will serve as general ground water specialist for other HRI environmental research programs.

Persons interested in applying for the position should, before March 31, 1983, send curriculum vita and names of three professional references to:

Darrell R. Fishel
Business Manager
Holcomb Research Institute
Butler University
Indianapolis, Indiana 46208

BUTLER UNIVERSITY

Butler University is an equal opportunity employer.

Marine Geochemist. The Marine Sciences Program, University of California at Santa Cruz, has a tenure-track position at Assistant Professor level, effective July 1983. Preference will be given to candidates able to complement and interact with existing marine science faculty in research areas such as seawater/particle interactions, early diagenesis, hydrothermal systems and seafloor volcanism, and paleogeochemistry; but candidates in all fields of marine geochemistry will be considered. The applicant will be expected to develop a strong research program with a sea-going component, and teach undergraduate and graduate courses. Send inquiries, curriculum vitae, a statement of research objectives, and three references by April 1, 1983, to: Dr. K.W. Bruland, Marine Science Search Committee, 272 Applied Sciences Building, University of California, Santa Cruz, CA 95064. The University of California is an equal opportunity/affirmative action employer.

The Pennsylvania State University/Faculty Positions. The Department of Geosciences invites applications for three (3) tenure track faculty positions, which are expected to remain open until filled by outstanding geoscientists in any of several fields of specialization. The faculty rank associated with each position is presently open, although salary funds currently available are sufficient for at most one senior full professorship. Salaries, which are competitive, will be commensurate with the experience and qualifications of the appointees. The successful candidates must be, or have demonstrated the potential to become, nationally recognized leaders in their fields. They must also have an interest in teaching and advising graduate and undergraduate students. Persons having an interest in collaborative research with other department faculty are preferred. Instructional and research areas in which particular needs have been identified include, but are not necessarily limited to: *aqueous geochemistry*, with emphasis on low-temperature rock-water (groundwater) interactions; *heavy isotope/trace element geochemistry*, with emphasis on element distribution systematics and their geological applications; *tectonics*, with emphasis on global geophysical and geological processes and observable manifestations of them; *sedimentary geochemistry*, with emphasis on quantitative aspects of carbonate petrology or clay mineralogy; *X-ray mineralogy*, with emphasis on petrological applications of crystallochemical methods; and *modeling* of dynamical earth processes using appropriate physical and mathematical representations.

The selection of persons to fill these three positions will be based in part on the extent to which their future research efforts will complement and further strengthen our programs in Geochemistry and Mineralogy, Geology, and Geophysics. Qualified persons should, therefore, include a brief description of their future research objectives with their résumés and the names of three references, and send to:

G. Wayne Burnham, Head
Department of Geosciences
The Pennsylvania State University
503-B Deike Building
University Park, PA 16802.

The Pennsylvania State University is an affirmative action/equal opportunity employer.

University of Kentucky/Department of Geology. The Department of Geology invites applications for two tenured track Assistant Professor level positions. Both appointments are for soft rock geologists preferably with some experience in industry and interests including one of the following: sedimentology, stratigraphy, carbonate petrology, organic geochemistry, or isotope geology. The successful applicants would be required to participate in active research, supervise graduate students and teach graduates and undergraduates. Familiarity with quantitative techniques is desired; Department has access to a variety of computational devices. Academic vitae and names of three references should be sent to Dr. Lyle Sendlein, Chairman, Search Committee, 321 Patterson Office Tower, University of Kentucky, Lexington, Kentucky 40506-0027. Closing date is March 1, 1983. Both appointments are to commence in August 1983, but an earlier date may be considered. Salary is negotiable.

The University of Kentucky is an equal opportunity/affirmative action employer.

Yale University. The Department of Geology and Geophysics solicits applications for a senior faculty position in stable isotope geochemistry with emphasis on ore deposits. Applicants should have at least five years research and teaching experience beyond the Ph.D., with emphasis on the use of the light stable isotopes in petrology, tectonics, sedimentology and paleobiology as well as ore mineral deposits.

Yale University is an equal opportunity/affirmative action employer and encourages women and members of minority groups to compete for this position.

Curriculum vitae, publications, and the names of three or more referees should be sent by *April 1, 1983* to: Karl K. Turekian, Chairman, Department of Geology and Geophysics, P.O. Box 6666, New Haven, CT 06511.

Postdoctoral Position in Dynamical Meteorology. The Department of Atmospheric Sciences at the University of Washington announces a research position for work on problems of large-scale dynamics and transport in the stratosphere and mesosphere. The successful applicant should have demonstrated capability in diagnostic studies of atmospheric circulation and/or in dynamical theory and modeling. Position is for one year with possibility of extension to three years and begins about July 1, 1983. Candidates should send curriculum vitae and three letters of reference to:

Prof. Conway B. Leovy
Department of Atmospheric Sciences AK-40
University of Washington
Seattle, WA 98195

For information: phone 206-543-1932.

The University of Washington is an affirmative action/equal opportunity employer.

ENGINEER III
(Geothermal Systems)

MS in Chemical or Mechanical Engineering plus 2 yrs. of experience or any equivalent combination of education and experience which provides the following: knowledge of geothermal exploration and hydrology, multi-phase process piping and heat exchanger design, engineering cost analysis, construction codes and standards, and design of simulation models to test effects of local, state and federal taxation policies on alternative energy developments, and APL programming; and ability to supervise. Salary is $22,868 and up DOE. Deadline is February 22, refer to position 194. Personnel Department (194-SB); Physical Science Laboratory/NMSU, P.O. Box 3548; Las Cruces, New Mexico 88003-3548. An Affirmative Action/Equal Opportunity Employer.

Department of Geology/The University of Alberta. The Geology Department has a tenure-track faculty position available from July 1, 1983. We invite applications from qualified individuals for appointment at the Assistant Professor level in the field of Stratigraphy. Preference will be given to applicants who demonstrate an ability to pursue a vigorous research program applying modern concepts and techniques in solving problems relevant to Petroleum Geology. The candidate is expected to teach advanced undergraduate courses in stratigraphy and courses(s) in his or her speciality, and to supervise M.Sc. and Ph.D. students. A Ph.D. is required. Current Assistant Professor salary range: $27,720-$30,696.

Interested applicants should submit a resume, publications, proposed research, and names and addresses of three referees to Dr. N.W. Rutter, Chairman, Department of Geology, University of Alberta, Edmonton, Alberta, Canada T6G 2E3. Closing date for applications is *March 15, 1983*.

The University of Alberta is an equal opportunity employer but, in accordance with Canadian immigration requirements, priority will be given to Canadian citizens and permanent residents of Canada.

Research Associate/Upper Atmospheric Physics. The National Research Council (Canada) is building a multi-instrument ground based research facility called CANOPUS. One part of CANOPUS is a Data Analysis Network which will provide interactive access to the CANOPUS data by scientists across Canada. A research associate position exists for a person who would be associated with implementing and operating this network. This position will allow some independent research on aspects of the CANOPUS data and the holder of the position would be encouraged to undertake such research.

The position requires a Ph.D. in some aspect of upper atmospheric physics (preferably ground based) and extensive computer experience. Any related experience in computer networking, etc. would be an advantage. The initial salary will be in the range from $24,000 to $27,000 per year, depending on experience. The appointment will be initially made for two years and commences as soon as possible.

Send resumes and the names of three referees to:

Professor J. A. Koehler
Institute of Space and Atmospheric Studies
University of Saskatchewan
Saskatoon, Saskatchewan S7N 0W0
Canada.

Faculty Position/Department of Geology, University of Illinois at Urbana-Champaign. Applications are solicited for a tenure track assistant professor position in experimental rock physics. The position is expected to be filled by August 1983. Salary is open depending upon experience. We are seeking a creative individual who is interested in either brittle or ductile behavior of rocks and their geological applications. An earned Ph.D. is required. The Department of Geology, the Materials Research Laboratory and the Engineering College of the University together offer excellent research facilities for rock physics studies. For equal considerations, interested individuals should send curriculum vitae, list of publications, research interests and the names of three or more references by March 5, 1983 to:

Albert T. Hsui
Department of Geology
University of Illinois at Urbana-Champaign
1301 West Green Street
Urbana, Illinois 61801
217-333-7752.

University of Illinois is an equal opportunity/affirmative action employer.

THEORETICAL OR EXPERIMENTAL SPACE PLASMA PHYSICISTS

NASA-MARSHALL SPACE FLIGHT CENTER
Huntsville, Alabama 35812

Two positions in theoretical or experimental space plasma physics are available in the Magnetospheric Physics Branch of the Space Science Laboratory at NASA's Marshall Space Flight Center. Either theoretical or experimental backgrounds will be considered with a preference given to theoretically oriented researchers to complement the extensive experimental activities of the branch. The Magnetospheric Physics Branch is involved in the analysis of low-energy plasma data from the ISEE, SCATHA, and Dynamics Explorer satellites, from sounding rockets, and from the Space Shuttle (STS-3). In addition, the group is presently carrying out the joint development of a variety of active space plasma experiments that will be flown on Spacelab One, Two, and Six.

Salaries range from $34,930 to $41,277 per annum, depending on experience.

Interested applicants may contact Dr. Charles R. Chappell at the Marshall Space Flight Center (205-453-3036). Forward resumes to the following address not later than March 1, 1983:

NASA-Marshall Space Flight Center
Space Science Laboratory
Attn: Dr. Charles R. Chappell, ES51-R2
Huntsville, AL 35812

NASA

An Equal Opportunity Employer U.S. Citizenship Required

The Public Service of Canada is an equal opportunity employer

La Fonction publique du Canada offre des chances égales d'emploi à tous

Public Service Canada / Fonction publique Canada

Research Scientist/Marine Geophysicist

Salary: $25,315 to $47,088
Ref. No.: 82-NCRSO-EMR-19 (4011)

Energy, Mines and Resources Canada
Geological Survey of Canada
Dartmouth, Nova Scotia

Duties

The Geological Survey of Canada is seeking a creative geophysicist to carry out original and cooperative research programs. These programs relate to geophysical studies of the earth and its tectonic processes, particularly by the development and testing of theoretical models where such programs have specific applications to the practical consequences of continental margin development, such as its resource potential. Some research programs may be totally independent, but others must provide theoretical geophysical input to programs already underway at the Atlantic Geoscience Centre. These programs are directed towards the investigation of the structure and origin of continental margins off Eastern Canada and the Arctic, basin analysis and hydrocarbon inventory of Eastern Canada, and quaternary marine geological processes. The scientist must exhibit originality, creativity, initiative and cooperativeness in carrying out such work and must communicate its results effectively.

Qualifications

Graduation from a recognized university with a doctorate degree in geophysics, geology, physics, mathematics or a related field; or a lesser degree with research experience and scientific productivity equivalent to that of a doctorate degree.

Clearance number: 112-299-012

Language requirements
Knowledge of English is essential.

Additional job information is available by writing to the address below.
Tout renseignement relatif à ce concours est disponible en français et peut être obtenu en écrivant à l'adresse suivante:

How to apply
Send your application and/or résumé to:
Joan Girling
National Capital Region Staffing Office
Public Service Commission of Canada
300 Laurier Avenue West
Ottawa, Ontario K1A 0M7
Tel.: (613) 593-5331, Ext. 403
Closing Date: March 18, 1983

Please quote the applicable reference number at all times.

Canada

Physical Oceanographer/Computer Programmer. The Florida State University is seeking applicants to help carry out advanced research that involves numerical modeling and time series analysis. Candidates should have an M.S. in physical oceanography or computer science and experience with principles of ocean circulation modeling and oceanographic data processing. Experience on CDC mainframes plus Fortran IV is particularly desirable. Position available to start immediately. Rank is Research Assistant. Salary will be competitive and according to training and experience. Send resume and professional references by March 28, 1983 to Y. Hsueh, Department of Oceanography, Florida State University, P.O. Box 1892, Houston, Texas 77251. An affirmative action/equal opportunity employer.

Faculty Positions/The University of Iowa. The Department of Physics and Astronomy anticipates one or two openings for tenure-track assistant professors or visiting professors of any rank in August 1983. Preference will be given to experimentalists in any area for the tenure-track positions. Current research interests include astronomy, atomic, condensed matter, elementary particle, laser, nuclear, plasma, and space physics. The positions involve undergraduate and graduate teaching, guidance of research students, and personal research. Interested persons should send a résumé and a statement of research interests and have three letters of recommendation sent to *Search Committee, Department of Physics and Astronomy, The University of Iowa, Iowa City, IA 52242.*

The University of Iowa is an equal opportunity/affirmative action employer.

Virginia Polytechnic Institute and State University/Structural Geologist. The Department of Geological Sciences invites applications for a tenure-track position in Structural Geology at the Assistant or Associate Professor level. The position involves teaching at the graduate and undergraduate level and supervision of graduate student research. Candidates should be process-oriented with interests in field related problems. A Ph.D. and strong research potential are required. Closing date for applications is April 15. The position is available from September 1, 1983.

To apply send a vita with list of publications, summary of present and proposed research and the names of three references to: Kenneth A. Eriksson, Chairman of Search Committee, Department of Geological Sciences, VPI & SU, Blacksburg, VA 24061.

Affirmative Action/Equal Opportunity Employer.

Position in Petrology/Rice University, Houston, Texas. The Department of Geology has a tenure-track opening July 1983 with starting level of appointment depending on the experience of the candidate. The faculty member is expected to establish, or continue a vigorous research program in petrology and to participate in teaching in mineralogy-petrology. Research areas in which we are potentially interested include: igneous petrology, metamorphic petrology, ore deposition, experimental petrology, interactions of fluids with rocks and sediments. Isotope geochemistry, and other specialties are not excluded from consideration. Available research facilities of the Department include: electron-microprobe, ICP-spectrograph, Ar-Ar dating, and stable light isotope mass-spectrometry. Send curriculum vitae, a statement of planned research, and names of at least three references to Dr. A. W. Bally, Chairman, Department of Geology, Rice University, P.O. Box 1892, Houston, Texas 77251.

Rice is an equal opportunity employer.

Meetings

Announcements

Exploration Geophysics

'Complex Geology: A Geophysical Challenge' is the theme for the 36th Annual Meeting of the Midwest Society of Exploration Geophysicists to be held in Denver March 6–9, 1983. The meeting's organizers expect 60 technical papers in categories that encompass case histories; data processing; magnetotellurics, gravity, and magnetics; modeling; seismic inversions; three-dimensional geophysics; and vertical seismic profiling.

Full sessions will address vertical seismic profiling and the three-dimensional seismic techniques. Several nonseismic papers to be discussed include nonconventional techniques such as radiometrics.

For more information, contact the Denver Geophysical Society, P.O. Box 5228TA, Denver, CO 80217 (telephone: 303-425-5584).

Planetary Sciences

The 15th Annual Meeting of the Division for Planetary Sciences (DPS) of the American Astronomical Society (AAS) will be held October 17–20, 1983, in Ithaca, N. Y. Contributed reports from all areas of planetary science are welcome.

Titles for contributed papers must be submitted no later than August 1, 1983; abstracts in the usual AAS format are due August 15. Send titles and abstracts to the program chairman, Steven J. Ostro, Space Sciences Building, Cornell University, Ithaca, NY 14853. Questions regarding travel and accommodations should be directed to the local arrangements chairman, Joseph A. Burns, at the same address.

The Department of Astronomy and the Center for Radiophysics and Space Research at Cornell will host the DPS meeting.

Ozone Symposium

The International Ozone Commission of the International Association of Meteorology and Atmospheric Physics (IAMAP) will hold its next Quadrennial Ozone Symposium in Halkidiki, Greece, September 3–7, 1984.

The program includes discussions on recent developments in observational techniques; analysis of both surface-based and satellite ozone observations; chemical-radiative-dynamical model calculations; observations of relevant trace constituents and their budgets; laboratory measurements of chemical rate constants and absorption cross-sections; interaction of ozone and circulation; radiation topics relevant to atmospheric ozone; ozone-climate interaction; non-urban tropospheric ozone; and future directions. Invited and contributed papers will be delivered in both oral and poster sessions.

For more information, contact by June 1, 1983, Christos S. Zerefos, Chairman, Local Organizing Committee, Physics Department, Campus Box 149, University of Thessaloniki, Thessaloniki, Greece. Send a copy of your request to C. D. Walshaw, Secretary, International Ozone Commission, Clarendon Laboratory, University of Oxford, Parks Road, Oxford, OX1 3PU, U.K.

The deadline for abstracts, which must be in English or French, is February 1, 1984. Contributors will be notified of the acceptance of their papers in April 1984.

The symposium is cosponsored by the Commission of the European Communities, the Academy of Athens, and the World Meteorological Organization.

Reflection Seismology

The International Symposium on Deep Structure of the Continental Crust: Results from Reflection Seismology will be held June 26–28, 1984, at Cornell University in Ithaca, N.Y. Among the topics to be covered are the results of seismic reflection profiling of the deep continental crust in countries throughout the world; structure of orogenic belts; nature of the Moho; mechanisms of continental accretion; and state-of-the-art techniques in deep seismic reflection profiling. The Cornell geological sciences department is sponsoring the conference.

For additional information on the conference, the submission of abstracts, or registration information, contact Muawia Barazangi, Conference Coordinator, Department of Geological Sciences, Cornell University, Ithaca, NY 14853 (telephone: 607-256-6411; Telex: 937478).

Cretaceous Climates

The Geological Society of America (GSA), with the International Geologic Correlation Program, will sponsor a Penrose Conference entitled 'Cretaceous Climates' October 2–7, 1983, in the Colorado Rockies.

Many hypotheses have been presented to describe or explain warm, equable, 'ice-free' geologic periods. The Cretaceous period is of particular interest because it is the largest contrast from the present-day 'glacial' regime that can be well documented. As such, Cretaceous paleoclimatic studies have implications for a wide variety of problems in the geologic sciences and for climate in general. In order to develop better interpretations, test hypotheses, and formulate climate model experiments, it is necessary to develop multidisciplinary associations to take full advantage of the Cretaceous geologic record and modern concepts of oceanic and atmospheric processes.

One major objective of the conference is to bring together scientists from a diverse group of geologic disciplines actively working on problems directly related to Cretaceous paleoclimates. The geologic record of Cretaceous climatology, including paleobotany, vertebrate paleontology, micropaleontology, sedimentology, and isotopic geochemistry, will be a major focus. This focus will include a global coverage of the geologic record incorporating data from continents, epicontinental seas and shelf regions, and the surface and deep oceans.

Cretaceous paleogeography and plate reconstruction will be a second focus. The conference also will take advantage of recent climate model experiments that are based on the physical laws that govern the atmospheric and oceanic circulation.

A one-day field trip to the Pueblo, Colo., area will be held in the middle of the conference to examine a complete Cretaceous sea level cycle and the associated biologic and climatic record.

Applications should be sent to Eric Barron, National Center for Atmospheric Research, P.O. Box 3000, Boulder, CO 80307, by June 1, 1983. Those desiring to attend the conference should include a brief description of the topics they wish to contribute or the reason for attending the conference. Other conference convenors include William Hay (museum, University of Colorado, Boulder) and Erle Kauffman (department of geology, University of Colorado, Boulder).

Geophysical Fluid Dynamics

An international meeting entitled 'Turbulence and Predictability in Geophysical Fluid Dynamics and Climate Dynamics' will be held June 14–24, 1983, in Varenna, Italy. It is officially designated as a course by the Italian Physics Society, which is the major sponsor.

The course addresses itself to advanced graduate students and junior postdoctoral scientists studying or active in the atmospheric and oceanographic sciences and related disciplines. Topics will include experimental, numerical, observational, and theoretical results about fully developed turbulence, its onset, and its predictability. Quasi-geostrophic, planetary, mesoscale, and microscale turbulence in the atmosphere and in the ocean will be emphasized. The dynamics of climate and predictability on various time scales will be discussed in the same context.

Prospective participants should write to R. Benzi, scientific secretary of the course, Centro Scientifico IBM, Via del Giorgione 129, 00147 Roma, Italy. A vita and two letters of recommendation should accompany applications from junior candidates. Some limited travel support will be available for junior participants with no other source of travel funds. A small number of senior observers also can be accommodated. These potential participants should also write to Benzi and, if they wish, may include a vita and list of publications. Applications should be mailed by March 15. The total number of participants is limited to 70.

STUDENT OPPORTUNITIES

Graduate Scholarships in Geophysics/University of Wyoming.
Amoco and Chevron Fellowships
M.S. and Ph.D. levels
Up to $10,500/year plus tuition
Research support
Research and Teaching Assistantships
$5,500–7,200/academic year
$2,500 summer stipend
Tuition
Hill Fellowships
Variable stipends
Areas of geophysical research at Wyoming:
Reflection seismology
Gravity and magnetic potential field studies
Physical properties
Paleomagnetism and rock magnetism
Thermal processes
Crustal structure and magnetism
Tectonic modeling
Seismic data processing
Contact: Dr. Kevin P. Furlong
Dept. of Geology/Geophysics
University of Wyoming
PO Box 3006 Univ. Station
Laramie, WY 82071
307/766-4379.

Graduate Fellowships in Coastal and Continental Shelf Sedimentation. The Geology Department of Dalhousie University invites applications for graduate fellowships leading to M.Sc. and Ph.D. degrees with specialization in the field of coastal and continental shelf sedimentation. Potential research areas include shoreface and sediment processes, instrumentation for sediment transport studies and construction of coastal facies models. Opportunities exist to take part in the upcoming Canadian Coastal Sediment Study and to gain scientific cruise experience on research vessels from Bedford Institute of Oceanography. Awards cover a calendar year stipend and are valued, after fees are deducted, between $6300–$8000. For further information or application please write:

Dr. R. Boyd
Geology Department
Dalhousie University
Halifax, Nova Scotia
CANADA B3H 3J5.

Graduate Research Assistantships Available/Department of Meteorology, South Dakota School of Mines and Technology. Several graduate research assistantships are available beginning Fall 1983 in the areas of numerical cloud modeling, cloud physics, weather modification, radiative transfer, radar meteorology, mesometeorology, and air pollution chemistry and physics. Graduate study can lead to a Master of Science degree in Meteorology at SDSM&T as well as a Ph.D. through a cooperative program with Colorado State University. Current areas of research emphasis include: 1) numerical cloud modeling at the single-cloud and mesoscale level, including acid rain formation, 2) design and evaluation of field experiments and operations in weather modification, including hail suppression, 3) aircraft and radar investigations of thunderstorms, 4) radiation transfer and remote sensing studies, 5) mesoscale data analysis, and 6) analysis and source apportionment of atmospheric particulate matter. Stipends for the nine-month academic year vary from $4,400 to $5,600. Full-time summer employment generally is available. For further information contact Dr. Briant L. Davis, Acting Head, Department of Meteorology, South Dakota School of Mines and Technology, Rapid City, South Dakota 57701-3995 (telephone 605/394-2291).

SERVICES, SUPPLIES, COURSES, AND ANNOUNCEMENTS

Strain Measurement: Techniques and Tectonics Implications, Sponsored by the Structural Geology and Tectonics Division of the Geologisches Institut, ETH Zentrum Zurich, Switzerland and R. Kligfield, Department of Geological Sciences, University of Colorado, Boulder, Colorado, USA.

Over the past few years many new practical techniques for measuring rock strain have been developed and, as a result of these studies, major advances have been made in our understanding of the significance of small and large scale features of tectonically deformed rocks. The short course will review the relationships between displacement and strain, and discuss the most practical ways that strain can be determined in the field and in the laboratory. Particular emphasis will be given to an analysis of strain variation over a wide range of scales and to a discussion of the significance of these variations in terms of tectonics processes.

The course will begin on Thursday evening, November 3, and will end at noon on Saturday, November 5. Lectures and workshops will be held at the Indiana Memorial Union, University of Indiana, Bloomington, Indiana, and accommodations will be at a nearby hotel. The fee of $150 includes: lecture notes, charter bus transportation from Indianapolis to Bloomington on November 3 and return to the Indianapolis airport on November 5, all meals except breakfast, and lodging.

Attendance will be strictly limited to 48 participants. Please make your plans now to attend this outstanding short course. Details regarding application procedures will be announced in the July issue of the Division Newsletter and the August issue of News and Information. In the interim please address all inquiries to Roy Kligfield.

FIFTH CONFERENCE ON THE PHYSICS OF THE JOVIAN AND SATURNIAN MAGNETOSPHERES

Cambridge, Massachusetts
June 21–24, 1983

Sessions: on satellite effects on the magnetosphere, interaction of the magnetosphere with rings, dust, and satellite surfaces, radio and plasma wave emission in relation to particle and field structure, energetic particles, magnetospheric configuration, dynamics, and energy budget.
Invited and Contributed Papers
Abstract Deadline: *March 15, 1983*
Further Information: Jupiter/Saturn Conference c/o Prof. H. S. Bridge, 37-241, Massachusetts Institute of Technology, Cambridge, MA, 02139, (617) 253-7501.

In addition to the Italian Physics Society, the course is sponsored by the Italian Ministry of Public Instruction, the Consiglio Nazionale delle Richerche (CNR), the U.S. National Science Foundation, the National Aeronautics and Space Administration, and the American Meteorological Society.

Lake and Reservoir Management

The North American Lake Management Society will sponsor an international lake and reservoir management symposium October 18–20, 1983, in Knoxville, Tenn.

Symposium objectives include presenting state-of-the-art lake and reservoir management techniques; exchanging information among researchers, managers and users; identifying research and management needs and goals; and identifying the role of specific lake and reservoir management policies in the overall use of the resource. Among the sessions planned are water quality assessment methods; watershed management; modeling techniques and innovations; acidic precipitation effects on surface waters; agricultural runoff and water quality; urban runoff and water quality; and political realities of lake management.

Abstract submission deadline is March 31, 1983. Length should be limited to two double-spaced pages. Papers from principal investigators and students are welcomed. Those prepared by August 31, 1983, and presented at the meeting will be published in a proceedings. Abstracts should be sent to Lowell Klessig, College of Natural Resources, University of Wisconsin, Steven's Point, WI 54481 (telephone: 715-346-3783). Interested persons not presenting a paper but wish additional information about the symposium should contact Wayne Poppe, Tennessee Valley Authority, 248 401 Building, Chattanooga, TN 37401 (telephone: 615-751-7353).

1983 AGU SPRING MEETING

May 30–June 3

The 1983 Spring Meeting of the American Geophysical Union will be held in Baltimore from Monday, May 30, to Friday, June 3, at the Baltimore Convention Center. The convention center is linked by an elevated pedestrian walkway to Harbor Place, a development of colorful and unique boutiques and restaurants overlooking Baltimore harbor.

Hotel Accommodations. Blocks of rooms are being held at the Hilton, the Hyatt Regency, the Holiday Inn, the Howard House, and the Harbor City Inn for those attending. Read the housing application and mail the **completed application form to the housing bureau early** to ensure reservations at your preferred hotel.

Registration. Everyone who attends the meeting must register. Preregistration (received by May 11) saves you time and money, and the fee will be refunded if AGU receives written notice of inability to attend by May 26. Registration rates are as follows:

	Pre-registration	One Day
Member	$85	$32.50
Student member	$32	$16
Nonmember	$85	$42.50
Student nonmember	$39	$19.50
Retired senior member	$32	$16

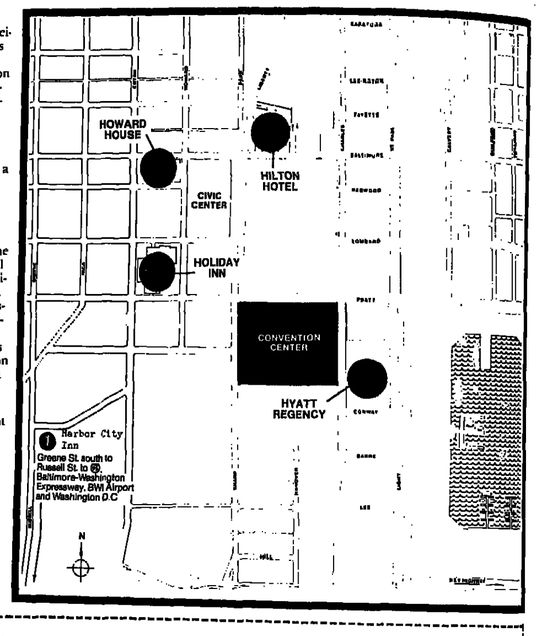
Registration for 1 day only is available at one half of the above preregistration rates, either in advance or at the meeting. Members of the American Meteorology Society, the American Society of Photogrammetry, Union Geofisica Mexicana, and the American Congress on Surveying and Mapping may register for the meeting at the AGU member rates.

The difference between member (or student member) registration and nonmember registration may be applied to AGU dues if a completed membership application is received at AGU by July 25, 1983. Current AGU annual membership rates are $20 for members and $7 for student members.

To preregister, fill out the registration form, and return it with your payment to the AGU office before May 11. Your receipt will be included with your preregistration material at the meeting. Preregistrants should pick up their registration material at the preregistration desk at the Convention Center. Monday through Friday hours are 8 A.M. to 4 P.M. On Sunday, May 29, registration hours are 5:30–7:30 P.M. in the lobby of the Hilton Hotel. Complimentary badges for guests not attending the scientific sessions will be available at the registration desk.

Transportation. For the visitor arriving at Baltimore-Washington International Airport (BWI), it is only an 8-mile ride to downtown Baltimore. Be sure to read the special announcement about discounted airfare, which also applies to flights to and from Washington airports.

Scientific Sessions. The preliminary program with abstracts will be published in *Eos*, May 3. All scientific sessions will be held at the convention center.



Ahoy! *Sail Back into Baltimore*

1983 AGU SPRING MEETING

May 30–June 3

HOTEL ACCOMMODATIONS

PARTICIPATING HOTELS	HOTEL CODE	ROOM RATES
Hyatt Regency 300 Light Street (301) 528-1234	HRDT	Single: $58.00 Double: $68.00 Twin: $68.00 Extra person: $15.00
Baltimore Hilton 101 W. Fayette Street (301) 752-1100	BHDT	Single: $51.00 Double: $61.00 Twin. $61.00 Extra person: $10.00 Parlor + 1 $150.00 to $190.00 Parlor + 2 $200.00 to $250.00
Holiday Inn - Downtown 301 W. Lombard Street (301) 685-3500	HIDT	Single: $39.00 Double: $47.00 Twin. $55.00 Extra person: $10.00
Howard House Hotel 8 North Howard Street (301) 539-1860	HHDT	Single: $33.00 Double: $38.00 Twin: $42.00 Parlor + 1 $52.00 Extra person: $10.00
Harbor City Inn 1701 Russell Street (301) 727-3400	HCIB	Single: $32.00 Double: $37.00 Twin: $37.00 Extra person: $5.00

PARKING: Hyatt/$6.00* Hilton/$2.60* Holiday Inn/free Harbor City Inn/free - (location requires car or bus transportation to Convention Center)

*** Subject to change.**

All hotel reservations must be made on the housing form by April 25, 1983. No telephone requests will be accepted. Confirmations will be mailed directly to registrants by the individual hotels. After confirmation has been received, changes and cancellations should be made with the hotel directly.

Mail your completed form directly to:

Housing Coordinator
AGU Spring Meeting
Baltimore Housing Bureau
1 East Pratt Street
Baltimore, Maryland 21202

PLEASE RETAIN THIS FORM FOR YOUR RECORDS

American Geophysical Union
SPRING 1983 MEETING

May 30–June 4, 1983
Baltimore, Maryland

Housing Coordinator
AGU Spring Meeting
Baltimore Housing Bureau
1 East Pratt Street
Baltimore, Maryland 21202

HOUSING APPLICATION FORM

READ CAREFULLY:

Please print or type (pica spaced) all information abbreviating as necessary. Confirmation will be sent by the hotel to the individual named in Part I. If more than one room is required, *this form may be photocopied.*

PART I

REQUESTOR
LAST NAME FIRST
NAME OF COMPANY OR FIRM
STREET ADDRESS OR P.O. BOX NUMBER
CITY STATE ZIP U.S.A.
COUNTRY AREA CODE PHONE NUMBER

PART II

INSTRUCTIONS: Select *THREE* Hotel/Motels of your choice from the list of participating facilities, then enter the appropriate code letters in the boxes below.

FIRST CHOICE HOTEL CODE — SECOND CHOICE HOTEL CODE — THIRD CHOICE HOTEL CODE

NOTE: Rooms are assigned in "First Come First Serve" order and if none of your choices are available, another facility will be assigned based on a referral system arranged by your convention organizer. A cut-off date is in effect and your application may not be processed if received after 14 days prior to your arrival date.

***AGU housing registration deadline is April 25.**

PART III

INSTRUCTIONS:
1. Select type room desired with arrival and departure dates.
2. *PRINT* or *TYPE* names of *ALL* persons occupying room.
3. If more than two people share a room, check twin and the hotel will assign two double beds.

CHECK ONE

- ☐ SINGLE (Room with one bed one person)
- ☐ DOUBLE (Room with one bed two persons)
- ☐ TWIN (Room with two beds two persons)
- ☐ P + 1 (Parlor plus one-bedroom suite)
- ☐ P + 2 (Parlor plus two-bedroom suite)
- ☐ EXTRA PERSON

Arrival Date MO. DAY.
Departure Date MO. DAY.
Arrival Time AM PM

Guest Names (Print Last Name First)
1.
2.
3.
4.

IMPORTANT NOTE: Hotel *MAY* require a deposit or some other form of guaranteed arrival. If so, instructions will be on your confirmation form.

Social Events. An Ice Breaker on Monday evening at the convention center is the opening social event of the meeting.

Complimentary refreshments will be served daily in Exhibit Hall A. Coffee breaks are from 9:30–10:30 A.M. and beer breaks from 2:45–3:45 P.M.

Awards Ceremony and Reception. The Awards Ceremony will be held in the Francis Scott Key Ballroom of the Hilton Hotel at 6:00 P.M. on Wednesday, June 1. All meeting participants are invited and are urged to attend. A Reception will follow the ceremony; you can meet and congratulate those being honored and share a glass of wine with them.

President's Dinner. The President's Dinner in honor of the medalists, awardees, and fellows will begin at 8:00 P.M. at the Hilton. It will be a more lavish and formal affair; black tie is optional. Tickets for the dinner are $25 per person. Purchase your tickets with your preregistration.

Exhibits. The exhibit area in Exhibit Hall A, will open 9 A.M. Tuesday and will remain open through Thursday between 9 A.M. and 4 P.M.

Exhibitors confirmed to date are:

Academic Press Inc.
American Geophysical Union
Defense Mapping Agency/HTC
Elsevier Science Publishing Company, Inc.
Nature's Own
Kinemetrics, Inc.
Phoenix Geophysics Ltd.
Sapphire Instruments
Schonstedt Instrument Co.
Teledyne Geotech
Terra Technology
U.S.G.S.

Business Meetings and Section Luncheons. The AGU Council will meet Tuesday, May 31, at 5:30 P.M. The annual business meeting of the union will follow the Council meeting. Members are welcome.

The Solar-Planetary Relationships Section business meeting will be on Thursday following an afternoon technical session. Refreshments will be served.

Section luncheons will be held in the Hyatt Regency. Rooms will be published in the at-meeting program. Please indicate on the registration form which luncheon you plan to attend and include payment. Cost is $9.50 per ticket (except for the Seismology luncheon).

The Oceanography luncheon will be held on Tuesday. Bruce Robeson, University of California at Santa Barbara will speak on the "Status of the UNOLS Research Fleet."

The luncheons of the Geomagnetism and Paleomagnetism, Hydrology, and Planetology/Volcanology, Geochemistry, and Petrology sections will be held on Wednesday.

The Seismology luncheon, sponsored by Kinemetrics, Inc., Teledyne Industries, Inc., and W. F. Sprengnether Instrument Co., Inc., will also be on Wednesday; cost is $5.00 per ticket.

The Atmospheric Sciences, Geodesy, and Tectonophysics luncheons will be on Thursday.

RETURN THIS FORM WITH PAYMENT TO:
Meetings Registration
American Geophysical Union
2000 Florida Ave., N.W.
Washington, D.C. 20009

PLEASE PRINT CLEARLY

NAME ON BADGE

AFFILIATION

MAILING ADDRESS

Telephone #
HOTEL

Days you plan to attend.
☐ Monday ☐ Wednesday ☐ Friday
☐ Tuesday ☐ Thursday

Please check appropriate box.
Members of the cooperating societies may register at AGU member rates.
Member badges are blue on white.
Nonmember badges are red on white.
☐ Member AGU ☐ Nonmember
☐ Member cooperating society.
AMS-American Meterological Society
ASP-American Society of Photogrammetry
ACSM-American Congress on Surveying and Mapping
UGM-Union Geofisica Mexicana

Nonmembers
The difference between member (or student member) registration and nonmember registration may be applied to AGU dues if a completed membership application is received at AGU by July 25, 1983. Current AGU annual membership rates are $20 Members; $7 Student Members.

Preregistrants
Your receipt will be in your preregistration packet. The registration fee will be refunded if written notice of inability to attend is received in the AGU office by May 26. The program and meeting abstracts will appear in the May 3 issue of EOS, which is mailed to all members of AGU in advance of the meeting.

Office Use Reference Number

AGU 1983 SPRING MEETING
MAY 30–JUNE 4, 1983
Baltimore, MD.

REGISTRATION FORM
DEADLINE FOR RECEIPT OF PREREGISTRATION MAY 11, 1983

(rates applicable only if received by May 11, with payment)

	More than one day	One day
MEMBER	☐ $65	☐ $32.50
STUDENT MEMBER	☐ $32	☐ $16
NONMEMBER	☐ $85	☐ $42.50
STUDENT NONMEMBER	☐ $39	☐ $19.50
RETIRED SENIOR MEMBER	☐ $32.	☐ $16
ABSTRACTS (May 3, 1983, EOS)		☐ $5
PRESIDENT'S DINNER WEDNESDAY EVENING		☐ $25

SECTION LUNCHEONS

Circle section and indicate number tickets. All tickets are $9.50 except for Seismology which is sponsored, cost is $5.

- ☐ Atmospheric Sciences-Thursday
- ☐ Geodesy-Thursday
- ☐ Geomagnetism and Paleomagnetism-Wednesday
- ☐ Hydrology-Wednesday
- ☐ Oceanography-Tuesday
- ☐ Planetology/Volcanology, Geochemistry and Petrology-Wednesday
- ☐ Seismology-Wednesday
- ☐ Tectonophysics-Thursday

Charge to ☐ American Express ☐ Visa ☐ Master Card

Card Number

Expiration Date

Signature

Other payments (Please identify) $

Total enclosed $

(All orders must be accompanied by payment or credit card information. Make check payable to AGU.)

Office Use
Code
Check No.

Airfare Information

Special 30% Discounted Air Fares Available When You Fly UNITED or DELTA to Baltimore.

UNITED

Your toll-free number for flight reservations: 800-521-0810 (Michigan residents 800-482-0243)

Your AGU Convention Number is:
6318

Special arrangements have been made with United Airlines to offer you a special discount off regular roundtrip coach fares available only when you call the United toll-free number at United's Convention Desk: 5:30 A.M.–5:30 P.M. EST Monday through Friday.

Just call the above number, available to those within the 48 contiguous states. Ask for the Convention Desk. Tell them you are attending the AGU convention in Baltimore, and give them your AGU Convention Number: 6318.

Here are the details on your special AGU convention fare:
- *30% lower than the normal roundtrip coach fares in effect at the time of your ticket purchase.*
- *No minimum stay requirement.*
- *Travel may commence no earlier than May 23, 1983, and must be completed on or before June 10, 1983.*
- *Reservations should be made as early as possible. The final date reservations and ticketing is May 27, 1983.*
- *Ticket purchases may be made through United, your travel agent, or directly with the airline when you call. If you wish to do so, you may purchase your ticket through an authorized travel agency. However, YOU, not your travel agent, should call United's unlisted number*

Special Note

In the current competitive 'air fare war' there are 'supersaver' fares and other sporadic and short-lived discounted fares from specific cities to Baltimore. These fares have restrictions and are limited. United's convention specialists will assist you in determining if your travel plans meet these specific restrictions and will assist you in making reservations at the best available rate.

Members in Hawaii: Call your local United reservations office for assistance. Identify yourself as attendees of the AGU meeting in Baltimore and ask your reservation agent to queue your record to Detroit 56.

DELTA

Delta Air Lines, in cooperation with the American Geophysical Union, is offering a special convention rate, the Y283, which affords a savings of at least 30% for attendees traveling on Delta to their meeting. Departure to Baltimore must be from your home city between May 28 and June 1, 1983. Reservations must be confirmed and tickets purchased seven (7) days prior to your departure from your trip via Delta. If special fares which represent a savings greater than our Convention Fare (Y283) are available to Baltimore, Delta will attempt to confirm your reservations at that rate. For reservations and information call Delta's TOLL FREE WATS line or your Travel Agent.

CALL DELTA TOLL FREE!
In 1-800-241-6760, Continental U.S.
In 1-800-282-4538, Georgia ONLY.

AGU, United and Delta Airlines are working together to make your convention travel as convenient as possible. Please call Delta and identify yourself as attendees of the AGU meeting in Baltimore and ask your reservation agent to queue your record to Detroit 56.

Geophysical Year

New Listings

The complete Geophysical Year last appeared in the December 21, 1982, *Eos*.

A boldface meeting title indicates sponsorship or cosponsorship by AGU.

March 6–9, 1983 36th Annual Meeting, Midwest Society of Exploration Geophysicists, Denver, Colo. (Denver Geophysical Society, P.O. Box 5226TA, Denver, CO 80217; telephone: 303-425-5584).

June 14–24, 1983 Turbulence and Predictability in Geophysical Fluid Dynamics, Varenna, Italy. Sponsors, Italian Physics Society, Italian Ministry of Public Instruction, Consiglio Nazionale delle Richerche, U.S. National Science Foundation, National Aeronautics and Space Administration, and American Meteorological Society. (R. Benzi, Scientific Secretary, Centro Scientifico IBM, Via del Giorgione 129, 00147 Rome, Italy.)

July 18–20, 1983 Applied Probability in Biology and Engineering, Lexington, Ky. Sponsor, ORSA/TIMS. (J. Cani, Organizing Chairman, Department of Statistics, University of Kentucky, 857 Patterson Office Tower, Lexington, KY 40506.)

September 7–10, 1983 AIPG Annual Meeting, Jackson Hole, Wyo. Sponsor, American Institute of Professional Geologists. (Gene R. George, General Chairman, P.O. Box 2775, Casper, WY 82601; telephone: 307/205-9199.)

September 18–21, 1983 Eastern Section Annual Meeting, Mohonk Mountain House, New York. Sponsor, Seismological Society of America. (Ellyn Schlesinger-Miller or Noel Barstow, Lamont-Doherty Geological Observatory, Palisades, NY 10964; telephone: 914/359-2900.)

September 19–21, 1983 AGU Midwest Regional Meeting, Milwaukee, Wis. Convenor, Robert W. Taylor, Department of Geological Science, University of Wisconsin, Milwaukee, Wisconsin 53201. (AGU, Midwest Meeting, 2000 Florida Avenue, N. W., Washington, DC 20009).

October 2–7, 1983 Penrose Conference on Cretaceous Climates, Colorado Springs, Colo. Sponsors, Geological Society of America and the International Geologic Correlation Program. (Eric Barron, National Center for Atmospheric Research, P.O. Box 3000, Boulder, CO 80307).

October 3–7, 1983 **Chapman Conference on Reconnection in Earth's Magnetosphere,** Los Alamos National Laboratory, Los Alamos, N.M. (Meetings, AGU, 2000 Florida Avenue, N. W., Washington, DC 20009).

October 13–14, 1983 The Water Resources of Georgia and Adjacent Areas, Atlanta, Ga. Sponsors, Georgia Geologic Survey, Georgia Institute of Technology. (Bernd Kahn, Environmental Resources Center, Georgia Institute of Technology, Atlanta, GA 30332; telephone: 404/894-3776; or Ram Arora, Georgia Geologic Survey, 19 M. L. King, Jr., Drive, S.W., Atlanta, GA 30334; telephone: 404/656-3214.)

October 18–20, 1983 International Lake and Reservoir Management Symposium, Knoxville, Tenn. Sponsor, North American Lake Management Society. (To send abstracts, Lowell Klessig, College of Natural Resources, University of Wisconsin, Steven's Point, WI 54481; telephone: 715-346-3783. For additional information, Wayne Poppe, Tennessee Valley Authority, 248 401 Building, Chattanooga, TN 37401; telephone: 615-751-7333).

June 25–27, 1984 **Rock Mechanics in Protection and Productivity,** 25th U.S. Symposium on Rock Mechanics, Evanston, Ill. Sponsor, AGU. (Charles H. Dowding, Department of Civil Engineering, Northwestern University, Evanston, IL 60201; telephone: 312/492-7270.)

June 28–28, 1984 International Symposium on Deep Structure of the Continental Crust: Results from Reflection Seismology, Ithaca, N.Y. (Muawia Barazangi, Conference Coordinator, Department of Geological Sciences, Cornell University, Ithaca, NY 14858 (telephone: 607-256-641); Telex: 937478).

October 17–19, 1984 AIPG Annual Meeting, Orlando, Fla. Sponsor, American Institute of Professional Geologists. (Bobby J. Timmons, General Chairman, Timmons Associates, P.O. Box 50606, Jacksonville, FL 32250; telephone: 904/246-4533.)

Meeting Report

Advances in Core Drilling Technology

Some notable technical advances in drill design were reported at the meeting, held in Canada August 30–September 1, 1982, at the University of Calgary. Chief amongst these was a battery powered, computer assisted electromechanical core drill which has recently been used by the Danes in Greenland to continuously core to the base of the ice sheet at 2038 m. This is the deepest coring operation so far on the Greenland ice sheet. (The record for deep glacier drilling is held by the U.S. Army Cold Regions Research and Engineering Laboratory for the continuous coring through 2164 m of ice to bedrock at Byrd Station, Antarctica, in 1968). In early 1982, a current Soviet core drilling operation was reported to be at a depth of 2000 m at Vostok station, Antarctica, where the total ice thickness is about 4000 m; the goal of core drilling the entire ice thickness there could be achieved before the end of 1983.

A number of different versions of the now familiar Rufli-Rand electromechanical core drill for retrieving up to several hundred meters of dry, uncontaminated core at cold sites were described by Canadian, French, German, Japanese, and U.S. drillers. Several smaller mechanical coring devices have been specially designed for use at high mountain sites or on the Arctic sea ice.

Thermal drills (both hydrothermal and electrothermal types) are the other major class of ice drills. The more important electrothermal drills have been very successful in competing with the submersible electromechanical drills for deep core drilling operations. The electrothermal drills are currently championed by the Soviet and French drill engineers. Of great importance is the correct choice of a drilling fluid, especially for the deep holes and locations, such as east Antarctica, where the surface temperature can be as low as −57°C.

Ice drilling on the major ice sheets is now an international endeavor. Cooperation among nations is needed primarily to reduce each nation's financial commitment. Deep ice coring operations are now regularly penetrating well into and even beyond ice deposited during the last glacial (80,000–10,000 years B.P.). Availability of this core, some of it still in storage, has opened up a vast paleo-atmospheric research domain, involving isotope geochemistry, conventional ion geochemistry (to parts per billion concentrations), counting of particulate matter, and measurement of entrapped air and CO_2 content. Once the core has been extracted, the bore hole is then available for further measurements such as the temperature profile and deformation, which are both important input parameters to ice sheet stability models. Access holes have been drilled through the Ross Ice Shelf by a variety of drilling methods; these holes allow direct observations and measurements to be made at the base of the ice shelf, in the water beneath the shelf, and of the sediment on the sea bed.

New scientific research carried out on glaciers increasingly relies on the technology of ice drilling for its success. The existing large array of different ice drill units, some barely off the drawing boards, some still in active service, and others trapped in their icy graves, attest both to the ingenuity of their inventors and to the foresight of the scientists who promoted their concepts.

A proceedings of 26 papers is planned by the U.S. Army Cold Regions Research and Engineering Laboratory as a Special Report in early 1983.

This meeting report was prepared by G. Holdsworth *of Environment Canada, Calgary.*

Membership Applications Received

Applications for membership have been received from the following individuals. A letter after the name denotes the proposed primary section affiliation; the letter A denotes the Atmospheric Sciences section, which was formerly the Meteorology section.

Regular Member

Amanda J. Alexander (GP), Burton R. Barnes (S), Donald E. Barrick (O), Marvin A. Blizard (O), Larry E. Brazil (H), C. W. A. Browitt (S), Liqi Chen (O), John Copp (V), Frank Dehairs (O), Joan M. Delany (V), Dick S. Diller (SM), Paul M. Dragos (O), Thomas J. Echols (S), Sherman R. Ellis (H), Frederick W. Fallon (G), James L. Fasching (O), Paolo Favali (S), Jack Felbinger (H), Kenneth M. Ferer (O), Richard V. Fisher (V), H. Paul Freitag (O), Thomas E. Gerish (A), Domenico Giardini (S), Michael Gibbons (S), Martin U. Goldman (SS), Arthur Grantz (T), Amy Graybeal (O), Paul R. Greenblatt (O), R. A. W. Haddon (S), Stephen W. Hager (O), David A. Hale (O), Tod P. Harding (T), Leroy E. Heidt (A), Grant H. Heiken (V), Fred A. Hilder (O), Richard L. Huff (SM), Joep P. P. Huyamans (V), Alan W. A. Jeffrey (O), Thomas W. Jones (O), Terrence M. Joyce (O), Stephen W. Kahler (SS), Paul F. Kaskiewicz (SA), Masaru Katzu (G), Jack A. Kaye (A), H. Gregory Ketchen (G), James A. Koehler (SA), James S. Kuwabara (H).

Valery E. Lee (O), Stephen H. Lieberman (O), Jay Lindner (H), Hugh D. Livingston (O), Bruce M. Loeffler (V), Heinz H. Loosli (O), Shaun Lovejoy (A).

Mitsuhiro Matsu'ura (S), David McKay (V), Thomas H. Mitchell (GP), Peter Muller (O), Gerald B. Murphy (SM), A. S. Naidu (O), Shafik Nasser (S), Daniel G. Onderdin (O), Carol Lynn Ostergren (V), Daniel Pei (H), Robert F. D. Perret (A), Alain R. H. Poisson (O), Walter H. Pollock (A), Boris Ragent (P), Martin B. Richardson (A), Kevin B. Riehl (SM), Jay D. Romick (V), Antonio Rovelli (S), Helmut Rucker (SM).

David W. Schindler (O), Peter G. Self (V), Nicholas Shackleton (O), Ramesk D. Sharma, Carver S. Simmons (H), Brian M. Smith (V), Nobie H. Stone (SM), Mariella Tatrallyay (SS), Sargun Tont (O), John Robert Toth (O), Henk Van der Rijst (V), Robert J. Varga (T), Ortwin H. Von Zweck (O), George P. L. Walker (V), Wesley K. Wallace (T), Stephen I. Warshaw (A), Geoffrey S. Watson (GP), James B. Willett (SM), Reinhard A. Wobus (V), William H. Wooden (G).

Student Member

Arturo Aburto (A), Jeffrey C. Bailey (A), Jack Edward Barbash (H), Sabine Cappelle (C), Kathleen S. Craig (O), David Crisp (A), Abdalmajid Debbarh (H), David Hastings (O), Christina Heliker (V), Show-Ming Hwang (O), Douglas Kahn (T), Jill McCarthy (T), Claudia J. Mora (V), Ann M. Persoon (SM), Francesca Smareni (T), Alex Ruzicka (P), Lawrence Sanford (O), Martha W. Schaefer (V), David T. Smith (O), Kent C. Stanley (H).

Associate Member

Mark Dowdine (GP), Nancy C. Plant (V), John J. Shaw (H), William S. Weber (S).

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Aeronomy

0430 Composition (Stratosphere)
STRATOSPHERIC H_2O, CF_2Cl_2, AND $CFCl_3$ COMPOSITION STUDIES UTILIZING IN SITU CRYOGENIC, WHOLE AIR SAMPLING METHODS
Charles C. Gallagher (Air Force Geophysics Laboratory, Hanscom AFB, Massachusetts 01731), Charles A. Forsberg, Robert V. Pierl

The fluorocarbon and nitrous oxide content of the stratosphere have been studied as a function of altitude, latitude and time. Whole air samples have been gathered from a balloon platform, primarily through use of a cryogenic sampler. Twenty-two flights were conducted between 1975 and 1980, and gas chromatography was utilized to determine species mixing ratios in the retrieved samples. Results are evaluated in terms of various stratosphere models.
J. Geophys. Res., Green, Paper 2C1427

0440 Convection, diffusion, mixing, turbulence, and fallout.
FINE DOPPLER-RESOLUTION OBSERVATIONS OF THIN TURBULENCE STRUCTURES IN THE TROPO-STRATOSPHERE AT MILLSTONE HILL
P. B. Wand (M.I.T. Haystack Observatory, Westford, MA. 01886), P. K. Rastogi, B. J. Watkins and G. B. Goriot.

The 440 MHz radar at Millstone Hill (42.6°N, 71.5°W) was employed to examine the detailed evolution of turbulence structures in the tropo-stratosphere with a very fine Doppler-resolution of 0.12 Hz, corresponding to 4 cm radial velocity resolution. The measurement technique involved directing the antenna downwind at a low elevation angle (15° or 20°) and processing the echos from a range where the background wind shear was high. Although no attempt was made to obtain good range resolution, a wide variety of turbulence structures were evident by virtue of their different Doppler shifts in the presence of a high wind shear. Using arguments based on the eliminacion of "shear broadening" and the required velocity gradient to create instabilities, maximum layer thicknesses in the vicinity of 20–100 m were inferred. The implication of these observations to bulk transport of passive contaminants in the stratosphere is
J. Geophys. Res., Green, Paper 2C1498

0460 Planetary waves)
LOW-LATITUDE LIDAR OBSERVATIONS OF PLANETARY WAVES IN THE MIDDLE ATMOSPHERE DURING THE WINTER OF 1981–1982
A. Hauchecorne (Service d'Aéronomie du C.N.R.S., B.P. 3 91370 – Verrières-le-Buisson, France), M.L. Chanin

A quasi-continuous survey of the stratospheric and mesospheric temperature was performed, between June 1981 and April 1982, using the lidar station of the Observatory of Haute-Provence (44°N, 6°E). During the period of easterly winds in the lower stratosphere, i.e. from June to September, the variability of the temperature is observed to be very low. As long as prevailing winds are westerlies, from October to March, temperature profiles are continuously perturbed by planetary waves, with a maximum of amplitude in January 1982, before the "stratospheric warming" of the winter. Spectral analysis of the data indicates the presence of a well-defined 16-day wave interpreted as a free Rossby wave, and the existence of large perturbations with periods of 25 to 40 days which are tentatively explained as a succession of slowly upper stratospheric warmings due to the interference of planetary waves, Rossby waves and a stationary wave.
J. Geophys. Res., Green, Paper 2C1985

0460 Tides, waves and winds
SIMULTANEOUS NEUTRAL WINDS IN THE THERMOSPHERE AT ARECIBO: SIMULTANEOUS INCOHERENT SCATTER AND AIRGLOW OBSERVATIONS
R. G. Burnside (Space Physics Research Laboratory, University of Michigan, Ann Arbor, Michigan 48109), R. A. Behnke and J. C. G. Walker

Simultaneous measurements of ion and neutral wind velocities have been obtained at Arecibo, Puerto Rico, on several nights in both the summer and winter seasons. The diffusion velocity of O^+, calculated in an analysis using the accepted value for the molecular diffusion coefficient and the MSIS model atmosphere, is found to be in fairly close agreement with the observations. Incoherent scatter radar data have also been used to derive height profiles of the meridional neutral wind velocity. In general the meridional wind is fairly constant with altitude. However, prior to midnight in the spring and summer months, contours of constant velocity are often observed to slope downward with increasing time. Some degree of vertical wind shear is often observed between 0300 and 0500 AST as well. In the winter months, meridional wind velocities are lower, and the nocturnal variation of the wind field is less pronounced than at other seasons. (Neutral winds, thermosphere, molecular diffusion)
J. Geophys. Res., Blue, Paper 3A0109

0460
HEAT FLUX INDUCED BY GRAVITY WAVES
J. Weinstock (National Oceanic and Atmospheric Administration, Aeronomy Laboratory, Boulder, Colorado, 80303)

A derivation is given of the heat flux induced by large amplitude gravity waves; the flux exists where nonlinear or turbulent damping exceeds molecular damping. This case is typical of the middle atmosphere. The derivation is based on a simple algorithm for converting the linear dispersion relation for gravity waves into a nonlinear one and generalizes a recent derivation by Weinstock. The downward heat deposition flux is shown to cause local cooling where the waves are close to saturation, but could cause heating where the waves are far from saturation. It is then proved that the eddy heat flux is related to the diffusivity and to the wave momentum deposition flux by simple expressions. Hence, knowledge of one transport coefficient is practically equivalent to knowledge of the other two. The derivation is limited to waves that have zero randomicity.
Geophys. Res. Lett., Paper 3L0093

0499 General (Aeronomy)
OBSERVATIONS OF OPTICAL EMISSIONS OF STS-4
D.S. Nendo (Lockheed Palo Alto Research Laboratory, Palo Alto, CA 94304), D.L. Garrett and P.R. Backus

Following the discovery of intense vehicle glow of the space shuttle on the STS-3 mission, a new experiment to probe this phenomenon was developed and flown on the shuttle STS-4 mission. Instrumentation onboard was equipped with an objective transmission grating and several photographic exposures were taken of the shuttle tail from the aft flight deck window. Vehicle glow surrounding shuttle surfaces exposed to the ram direction was observed on a long (400 second) exposure. From analysis of the resulting spectral data it appears that the shuttle glow has a diffuse spectral component in the region 6300 to 6700Å. In addition, it has been possible to assess the spectral character of light emitted by the firing of a reaction control system thruster. Our data show that the light emitted from the thruster gases is confined to wavelengths shorter than 7200Å. (Vehicle glow, space shuttle optical emissions).
Geophys. Res. Lett., Paper 3L0099

Electromagnetics

0703 Antennas
THE ELECTROMAGNETIC FIELD IN A LAYERED EARTH INDUCED BY AN ARBITRARY STATIONARY CURRENT DISTRIBUTION
G. Kristensson (Inst. of Theoretical Physics, S-412 96 Göteborg, Sweden)

The subject of this paper is to calculate the fields in a layered earth induced by a current distribution. A general formulation is presented, which contains very few restrictions of the current distribution. For the simplest current distributions (dipole, circular and rectangular loops) we derive expressions for the fields, which contain a single integral (Hankel-field type). Numerical computations are presented for the above-mentioned sources, and some techniques for increasing the rate of convergence are discussed.
Rad. Sci., Paper 2S1813

0720 Electromagnetics (Electromagnetic Theory)
ON THE THEORY OF ELECTROMAGNETIC INDUCTION IN THE EARTH BY OCEAN CURRENTS
Alan D. Chave (Institute of Geophysics and Planetary Physics, Scripps Institution of Oceanography, University of California at San Diego, La Jolla CA 92093)

The theory of electromagnetic induction is extended to the case where the driving electric currents must be considered explicitly. Differential equations for independent poloidal magnetic (PM) and toroidal magnetic (TM) modes are derived directly from the governing equations for the Earth and the Maxwell equations. They are applied to induction by motional source fields in the ocean by deriving Green functions for the two modes in a conducting ocean, and the TM modes are shown to behave in very different ways as a function both of the ocean velocity field dynamics and of the electrical conductivity structure of the earth. The modes are closely associated with the Coriolis force definition of water currents and with coastline effects that limit the source scales in the ocean. The PM modes are induced by nondivergent electric currents that are fully contained within the ocean. Surface gravity waves and a Kelvin wave are examined in detail. The Kelvin wave result of Larsen [1968] is re-evaluated and, because the upper lithosphere was modeled as an insulator, significant errors in the magnetic induction values, caused by neglect of the TM mode, are revealed. The sensitivity of the TM mode magnetic field to lithospheric electrical conductivity suggests the use of tidal induced electromagnetic fields to probe the earth's conductivity structure. (Electromagnetic induction, oceanic sources)
J. Geophys. Res., Red, Paper 3B0024

0770 Radio Oceanography
ANALYSIS OF SCATTER MOTION EFFECTS IN MARSEN L-BAND SAR IMAGERY
J. Lajoie and R.A. Shuchman (Radar and Optics Division, Environmental Research Institute of Michigan, Ann Arbor, Michigan, 48107)

Synthetic Aperture Radar (SAR) L-Band images collected over the North Sea during the 1978 MARSEN experiment show numerous apparent point scatterers imaged with a degraded resolution in the along-track direction. The observed resolution of these features is consistent with a scatterer coherence time on the order of 10^{-2} sec, or a vertical acceleration on the order of 5 m/sec². Observations of the resolution as a function of the processor integration time tend to support the coherence time explanation. Similar coherence times have been measured for breaking waves by conventional high-resolution radars, suggesting that the same phenomena may be responsible for the features observed on the SAR imagery.
J. Geophys. Res., Green, Paper 2C1861

0760 Scattering
MULTIPLE SCATTERING THEORY FOR WAVES IN DISCRETE RANDOM MEDIA AND COMPARISON WITH EXPERIMENTS
L. Tsang (Remsen Wave Propagation Group, Boyd Laboratory, Division of Engineering Mechanics and Atmospheric Sciences Program, The Ohio State University, Columbus, Ohio 43210, U.S.A.) Y.H. Kuo, Bringi, V.N. Varadan and A. Ishimaru

Attenuation of electromagnetic waves by a random distribution of pair-correlated dielectric spheres is studied as a function of frequency and volume concentration of spheres. The main aim of this paper is to compare theoretical results obtained using a self-consistent multiple scattering formulation and measured values of attenuation for later spheres in water. The agreement between theory and experiment is very good.
Rad. Sci., Paper 3S0069

Exploration Geophysics

0910 Computer Applications
INVERSE SCATTERING FOR A LAYERED ACOUSTIC MEDIUM USING THE FIRST-ORDER EQUATIONS OF MOTION
M.S. Howard (Exploration Research Division, Conoco Inc., P.O. Box 1267, Ponca City, OK 74601)

The inverse scattering problem for a layered acoustic medium is considered from the first-order differential equation formulation, resulting in a vector formulation of the problem, and using a vector form of the Schrodinger inverse scattering methods. The result is a vector Marchenko equation. The solution for plane waves at normal incidence is given along with a good approximate solution which is easily obtainable and takes into account transmission loss not included in the normal WKBJ-Born approximation. A new solution for extracting separately the velocity and density of the medium using the reflection response for two different angles of incidence is given, which involves a nonlinear integral equation to relate the apparent travel times to depth.
GEOPHYSICS, VOL. 48, NO. 2

0910 Computer Applications
THE INFLUENCE OF OUT-OF-PLANE SURFACE PROPERTIES ON UNMIGRATED TIME SECTIONS
Jack E. Cohen (Department of Mathematics, University of Denver, Denver, CO 80208) Norman Bleistein

Both analytic and numerical means are used to demonstrate amplitude and phase behavior of reflections from three-dimensionally curved interfaces. In particular, the high-frequency geometrical optics approximation for the backward scattered wave field demonstrates that the phase of a reflection from a specular is determined by the (in general, different) positions of focal regions for the two principal curves at the specular reflection point. Thus the amplitudes and phases of events observed on seismic sections are nonlinear as much by the shape of the reflector as by the "out-of-plane" as by the shape in the plane of the section. Results of the numerical examples suggest possible pitfalls in traditional interpretation of two-dimensional seismic data.
GEOPHYSICS, VOL. 48, NO. 2

0920 Magnetic and electrical methods
RESISTIVITY/DEPTH MAPPING WITH AIRBORNE ELECTROMAGNETIC SURVEY DATA
Klaus-Peter Sengpiel (Bundesanstalt für Geowissenschaften und Rohstoffe, P.O. Box 51 0153, D-3000 Hannover 51, West Germany)

Using the homogeneous half-space as a universal interpretation model, all of the secondary field data obtained with a single-frequency airborne electromagnetic (EM) system that satisfies the superposed dipole condition can be converted to the model parameters P_2 (apparent resistivity) and d_2 (apparent depth). These parameters have been investigated for their behavior above various conductivity models and at various flight altitudes, first for theoretical examples and then for several applications in the field.

The values of P_2 and d_2 are good approximations of the true resistivity and true depth of an extended, buried conductor only where the shielding effect of the cover is small. Moreover, a depth value has a meaning only within the lateral limits and to select acceptable depth and resistivity values by means of the "area of d_2 confidence," which is derived from the horizontal gradient of log P_2 and the course of d_2.

The results of the resistivity/depth mapping method are presented in the form of two contour maps. Examples of theoretical application of the method, over known sulfide ore bodies and over a salt water intrusion, show that reliable data can be obtained on the depth, dip, and extent of these kinds of conductors, as well as on the approximate resistivity of the conductors and the host rock.
GEOPHYSICS, VOL. 48, NO. 2

0920 Magnetic and electrical methods
SPECTRAL ANALYSIS OF GRAVITY AND MAGNETIC ANOMALIES DUE TO A VERTICAL CIRCULAR CYLINDER
A. Bato (Instituto de Geofísica, Ciudad Universitaria, Mexico 20, D.F.) E. Bloch and C. Flores

Expressions for the spectra of gravity and magnetic anomalies due to a vertical right circular cylinder can be written in terms of a Bessel function and the sum of two exponentials. From the zeros of the amplitude spectra, which are the zeros of the Bessel function, an estimate of the radius of the cylinder can be obtained. The depths to the top and to the bottom either as exponents of the exponential terms and can be evaluated by taking ratios of the spectra at several frequencies. The density or the intensity of magnetization can then be easily estimated. For the magnetic case the eccentricity of the cylinder can be obtained from the slope of the phase spectra. The method has been tested on anomalies of various cylinders and was found to give good results.
GEOPHYSICS, VOL. 48, NO. 2

0920 Magnetic and electrical methods
MODELING OF SELF-POTENTIAL ANOMALIES NEAR VERTICAL DIKES
David V. Fitterman (U.S. Geological Survey, Box 25046, MS 964, Denver Federal Center, Denver, CO 80225)

The self-potential (SP) Green's function for an outcropping vertical dike is derived from solutions for the dc resistivity problem for the same geometry. The Green's functions are numerically integrated over rectangular source regions on the contacts between the dike and the surrounding material to obtain the SP anomaly. The analysis is valid for thermoelectrical source mechanisms. The types of anomalies can be produced by this geometry. When the two source planes are polarized in opposite directions, a monopolar anomaly is produced. This corresponds to the case of thermoelectrical properties of the dike being in contrast with the surrounding material. When the thermoelectric coefficients change monotonically across the dike, a dipolar anomaly is produced. In either case positive and negative anomalies are possible, and the greatest variation in potential will occur in the most resistive regions. Examples of the effect of changing different model parameters are given for sources that have constant intensity throughout the rectangular source regions. For these patch models the depth to the top of the source region is approximately equal to the distance between the minimum (or maximum) of the anomaly outside of the dike and the edge of the dike. Field data collected over a hot intrusive fissure are presented which have been modeled by the techniques described.
GEOPHYSICS, VOL. 48, NO. 2

0920 Magnetic and electrical methods
ANALYSIS OF AEROMAGNETIC MEASUREMENTS FROM THE CASCADE RANGE IN CENTRAL OREGON
G. Connard (Northwest Geophysical Associates, Inc., P.O. Box 1049, Corvallis, OR 97339-1049) R. Couch and M. Gemperle

Shallow Curie-point isotherm depths, indicated by the analysis of magnetic anomalies, young silicic volcanism, hot springs, and high heat flow, mark one of the important geothermal resource areas. Aeromagnetic measurements in the central Cascades between 43°00' and 43°15'N latitude and 121°00' and 122° 30'W longitude exhibit predominant northwest-southeast lineations and less prominent north-northeast to northeast-southwest lineations. Longer wavelength components of the magnetic anomalies (greater than 2.5 km), possibly related to deeper sources, trend approximately north-south parallel to the Cascade Range. Magnetic anomalies show a right-lateral offset of the High Cascades volcanism at 43°30'N latitude, which is consistent with the tectonic structures of the Basin and Range province southeast of the area. Magnetic source depth calculations show that the High Cascades occupy a structural depression or graben on the eastern side of the Western Cascades. Spectral analysis of the magnetic anomalies suggests that the High Cascades are underlain by Curie-point isotherm depths as shallow as 0 km. These shallow Curie-point isotherm depths imply thermal gradients greater than 50°C/km and surface heat flow greater than 105mW/m².
GEOPHYSICS, VOL. 48, NO. 3

0920 Magnetic and electrical methods
ELECTROMAGNETIC SOUNDINGS IN THE SEDIMENTARY BASIN OF SOUTHERN ONTARIO—A CASE HISTORY
E. Gomez-Trevino (Department of Physics, Geophysics Laboratory, University of Toronto, Toronto, Ontario, Canada M5S 1A7) R. N. Edwards

The results of electrical and electromagnetic (EM) soundings carried out in the sedimentary basin of southern Ontario are presented. The sounding sites are located strategically to take advantage of the dipping nature of the sedimentary formations. The sounding undertaken from shallow to deep sections. The vertical magnetic field transfer function, estimated with a conventional source EM system, is inverted and can be Schlumberger apparent resistivity are jointly inverted. For each site, the layered earth model containing the minimum number of layers is derived on the basis of the joint inversion enables up to eight distinct layers to be identified at some sites. The nonuniqueness or ambiguities in each model, for example a two-layer (conductively-thickness product equivalence of a deep thin conductive layer, are revealed through an eigenvalue analysis. The statistic analysis of the models of the deeper sections are resolved by a systematic, progressive alter-to-data correlation of electrical units across the basin. Typically, the conductivity of a conductive unit is measurable when it is at a shallow depth. In a deeper section, if the unit appears as a thin layer, it is resolved by the value of conductivity-removing the S-equivalence ambiguity. The individual inversions combined with the stratigraphic correlation produce an overall site-to-site model of the basin consistent with the known geologic section.
GEOPHYSICS, VOL. 48, NO. 3

0930 Magnetic and electrical methods
2D, TELLURIC FIELDS IN THREE DIMENSIONS: A REFINED FINITE-DIFFERENCE SIMULATION USING LOCAL INTEGRAL FORMS
John F. Hermance

A new finite-difference form is developed for simulating the distortion of telluric fields by 3-D anomalous conductivity structures. The technique ... electric current density crossing closed surfaces surrounding each mesh node. The resulting expressions, which are accurate to second degree, correctly describe first-order discontinuities in the ... normal to electrical discontinuities in the interior of the model. However, the new form in the cross-point finite-difference operator accounts for ... gradient (e.g., 10^0, 90^0) effects in the ... region about each node, which can lead to significantly improved accuracy near sharp, localized discontinuities ... where the anomalous field decays as $1/R^3$ or $1/R^4$ with ... distance.

Numerical simulations are compared with analytical solutions for two simple models: (1) a circular disk-shaped heterogeneity in a thin sheet, and (2) a sphere imbedded in a homogeneous, infinite medium. The comparison between the analytical and numerical results for both of these models indicates that an accuracy of better than a few percent is not exceptional.
GEOPHYSICS, VOL. 48, NO. 3

Atmospheric and Oceanic Physics

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Geotectonics

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0930 Seismic methods

NORMAL INCIDENCE LAYERED SYSTEM STATE-SPACE MODELS WHICH INCLUDE ABSORPTION EFFECTS

Fareydoun Amiuzadeh (Formerly University of Southern California, Los Angeles; presently Union Oil of California, Brea, CA) Jerry M. Mendel

We show how to include absorption effects in a normal incidence state-space model of a layered media system. Two models are discussed: a convolutional state-space model ...

... detected had it been present. To this end, the attenuation characteristics must be studied.

Frequently, coal seams are highly anisotropic waveguides. Perpendicular to the bedding plane one or two "cleat" or cleavage planes exist, along which the coal is extensively cracked and jointed. Recent work by Crampin (1978, 1981) and by Hudson (1981) has shown that such systems of parallel cracks in crustal rocks ...

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3770 Particles and Aerosols
THE 1980 ERUPTIONS OF MOUNT ST. HELENS: PHYSICAL AND CHEMICAL PROCESSES IN THE STRATOSPHERIC CLOUDS
R. P. Turco (R & D Associates, Marina del Rey, CA 90291), O. B. Toon, R. C. Whitten, P. Hamill, R. G. Keesee

The physical and chemical properties of the stratospheric clouds produced by the recent eruptions of the Mount St. Helens volcano are investigated. The large and diverse set of observational data collected in the high-altitude plumes of the May 18, May 25 and June 13, 1980 eruptions is organized and analyzed for evidence of the processes at work. The data are used to guide and constrain detailed model simulations of the volcanic clouds. For this purpose, a comprehensive one-dimensional model of stratospheric sulfate aerosols, sulfur precursor gases, and volcanic ash and dust is utilized. The model accounts for gas-phase and condensed-phase (heterogeneous) chemistry in the clouds, aerosol nucleation and growth, and cloud expansion. Computational results are given for the time histories of the gaseous species concentrations, aerosol size distributions, and ash burdens of the eruption clouds. The long-term buildup of stratospheric aerosols in the Northern Hemisphere and the persistent effects of injected chlorine and water vapor on stratospheric ozone are also investigated. It is concluded that SO_2, water vapor, and ash probably were the most important substances injected into the stratosphere by the Mount St. Helens volcano, both with respect to the widespread effects on composition, and the impact on climate. Despite the seemingly large magnitude of the Mt. St. Helens eruption, it is found that the volcano had little influence on the climate (~0.05 K surface cooling in the Northern Hemisphere) or on stratospheric ozone (~0.2% maximum hemispherical depletion). Remaining problems in the field of volcanic cloud physics and chemistry, and requirements for future experimental work, are discussed.

J. Geophys. Res., Green, Paper 3C0054

3780 Storms
LIGHTNING PROPAGATION AND FLASH DENSITY IN SQUALL LINES AS DETERMINED WITH RADAR
Vladislav Mazur (Cooperative Institute for Mesoscale Meteorological Studies, University of Oklahoma, Norman, Oklahoma, 73019), and W. David Rust (National Severe Storms Laboratory, Norman, Oklahoma 73069).

The propagation of lightning has been studied using radar techniques. The rise time of radar echoes is explained by ionized channel propagation through the radar beam. The calculated values agree well with those obtained experimentally. Measurements of the radial velocity of streamer propagation (along the antenna beam) show speeds of at least 2.5×10^5 m/s. The time-range variations in lightning echoes are indicative of (1) new ionization as streamers develop into different parts of the cloud, (2) channel decay during which adequate ionization exists for radar detection, or (3) continuing current. Lightning flash density has been determined for two squall lines, one in the USSR (using a 3-m wavelength radar) and the other in the United States (using a 23-cm wavelength radar). The United States study shows that the maximum lightning density tends to be near the leading edge of the precipitation zones in developing cells. As a cell in the squall line develops and the total lightning density increases, long discharges are produced, but the shorter ones predominate. In contrast, as the cell dissipates, short flashes diminish or cease, and the long flashes dominate the lightning activity. (Storms, electrical phenomena).

J. Geophys. Res., Green, Paper 2C1865

3790 Instruments and Techniques
AN AEROSOL AND GAS SAMPLING APPARATUS FOR REMOTE OBSERVATORY USE
W. D. Komhyr (NOAA Air Resources Laboratories, Boulder, Colorado 80303)

An air sampling apparatus is described that standardizes sampling height at 10 m or more above ground level for a field station, and that minimizes loss of particles and destruction and contamination of sampled trace atmospheric gases as air is conducted through the apparatus to various monitoring instruments. Basic design features render the apparatus useful for air sampling under widely varying climate conditions, and at station altitudes ranging from sea level to more than 4 km. Four systems have been built, and they have been used successfully since 1977 at the NOAA Geophysical Monitoring for Climatic Change (GMCC) program baseline stations at Point Barrow, Alaska; Mauna Loa, Hawaii; American Samoa, South Pacific; and the South Pole, Antarctica. (Air sampling, aerosols, trace gases).

J. Geophys. Res., Green, Paper 2C1997

3793 General (Meteorology)
COMPARISON OF LONGWAVE RADIATION CALCULATION METHODS OVER THE UNITED STATES
J. L. Hatfield (Land, Air and Water Resources, University of California, Davis, California, 95616), P. J. Reginato, and S. B. Idso

Longwave radiation models currently in use have been empirically derived and may only be applicable to small geographic areas. Data were collected at 15 locations in the United States to provide a data set from which the Brunt, Swinbank, Idso and Jackson, Brutsaert and Idso longwave models could be evaluated. Only clear sky data were used in the evaluation of the models and the data were constrained to the nighttime hours to avoid any solar radiation bias on the radiometer. The Swinbank and Idso and Jackson which correct for emittance solely on temperature provided the poorest fit across locations. The Brunt models with its original coefficients, the Brutsaert and Idso models were the most consistent over locations and could be utilized with less than 5% error. (Longwave radiation, sky emittance, empirical longwave models).

Water Resour. Res., Paper 2W1562

Oceanography

4765 Sea level
COASTAL SEA LEVEL RESPONSE TO FRONTAL PASSAGES ON THE LOUISIANA-TEXAS SHELF
Wen-Sen Chuang (Coastal Studies Institute, Louisiana State University, Baton Rouge, Louisiana 70803) and Wm. J. Wiseman, Jr.

Sea level variations resulting from wind forcing along the Louisiana-Texas shelf are examined on 5-month winter records. Local weather patterns during the winter are dominated by cold-front passages. The associated surface wind field is well organized, predominantly in the cross-shelf direction. Regional sea level response, however, shows considerable variability; it is mainly a response to alongshore wind at Galveston, but cross-shelf wind at Eugene Island. This spatially nonuniform response appears to be due to the different water depth over the inner shelf, which is shallower off Eugene Island and favors direct cross-shelf wind setup. A friction model is applied to each region, and the results compare well with observations. (Subtidal variability)

J. Geophys. Res., Green, Paper 2C1842

4799 General (Boundary Layer Circulation)
INITIAL MODEL RESULTS FOR ARCTIC MIXED LAYER CIRCULATION UNDER A REFREEZING LEAD
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At the temperatures in the Arctic Ocean mixed layer during lead induced surface water cooling, convection is primarily salinity-controlled due to continuous brine expulsion from newly forming ice. A nonlinear, time-dependent, convective model has been developed which simulates existing field data obtained on the circulation characteristics under and near a refreezing lead. The model uses typical arctic ocean ambient conditions as initial input and allows for imposition of varying geostrophic currents. The zero geostrophic current (free convective case) model output for typical lead surface salt input resulted in maximum horizontal current velocities of .02 m s⁻¹, eddy viscosities on the order of .01 m² s⁻¹, average salt fluxes beneath the lead of 3.3×10^{-5} kg m⁻² s⁻¹ and a subsequent increase in the depth of the mixed layer. The circulation cells are symmetric with respect to the lead axis. Imposition of a cross lead constant geostrophic current shows a resultant circulation cell asymmetry associated with increased salt advection in a forced convective regime. (Arctic, circulation, leads).

J. Geophys. Res., Green, Paper 2C1866

4705 Boundary Layer and Exchange Processes
REVISED PARAMETERS FOR MODELING THE TRANSPORT OF PCB COMPONENTS ACROSS AN AIR WATER INTERFACE
Richard F. Bopp (Lamont-Doherty Geological Observatory of Columbia University, Palisades, New York 10964)

A number of revisions of the data base and conceptualizations utilized in air-water transport models for PCB components are suggested. The most significant of these involves the assignment of physical chemical properties on the basis of degree of chlorination. The effect of temperature on the rate of transport is also discussed. The revised model is tested on a number of natural situations and compared to available data. (PCB components, air-water transport, chemical parameters).

J. Geophys. Res., Green, Paper 2C1884

4705 Boundary layer and exchange processes
THE SENSITIVITY OF UPPER OCEAN STRUCTURE TO TIME VARYING WIND DIRECTION
T.D. Dickey (Department of Geological Sciences, University of Southern California, Los Angeles, CA 90089-0741), J.J. Simpson

Observations and models show that sudden changes in the magnitude of the wind stress which occur within a time interval of one-half inertial period are most effective in increasing surface current speeds and mixing the upper layers of the ocean. The purpose of the present study is to quantify the effects of concurrent time dependent wind direction. The Mellor-Yamada level 2 1/2 turbulence closure model is used. A linearly stratified water column located at 30°N is chosen for all runs. A series of model runs was executed in order to determine the relative sensitivity of mixed layer depth and sea surface temperature to wind speed as compared with the rate of change of wind direction. The results indicate that the accuracy and time resolution of wind direction should be given special consideration in the design and interpretation of field experiments which will be used for testing prognostic mixed layer models. The results support the conclusion of the Satellite Surface Stress (S^3) Working Group that methods of supplementing scatterometer data are required for a proper implementation of upper ocean models which require wind direction variability as an input.

Geophys. Res. Lett., Paper 2L1910

4713 Circulation
OBSERVATIONS OF NEAR-SURFACE CURRENTS AND TEMPERATURE IN THE CENTRAL AND WESTERN TROPICAL ATLANTIC OCEAN
R. L. Molinari (National Oceanic and Atmospheric Administration, Atlantic Oceanographic and Meteorological Laboratories, 4301 Rickenbacker Causeway, Miami, Florida 33149)

Eleven satellite-tracked drifting buoys were deployed in the central South Atlantic Ocean during two austral summer and two austral winter cruises. Between 7°S and 11°S and 23°W and 31°W during austral winter, net buoy drift was to the west. Surface geostrophic flow was to the east between 7°S and 9°S. It is proposed that strong southeast trade winds can induce directly-driven surface flows to the west which are more intense than the eastward geostrophic flows associated with the South Equatorial Countercurrent (SECC). A sustained period of eastward drift within the SECC was observed during austral summer, when the trades are weaker. The trajectories indicate surface waters north of 8°S have a mean northward meridional component and those south of 8°S a southward component. The buoys which drifted north became entrained into the North Brazilian Coastal Current (NBCC) and those which drifted south, into the Brazil Current. One buoy left the NBCC at about 5°N to drift northeastward in the North Equatorial Countercurrent (NECC). This trajectory and historical ship drift reports suggest that the NECC may extend only to 35°W – 40°W during boreal winter. Temperature data obtained as the buoys drifted westward and northward suggest that increases in upper layer heat content can be attributed to heat fluxes through the sea surface.

J. Geophys. Res., Green, Paper 3C0031

4720 Distribution and water masses
WATER MASS ANALYSIS IN THE GERMAN BIGHT DURING MARSEN, PHASE I
G. A. Becker (Deutsches Hydrographisches Institut, Bernhard-Nocht-Str. 78, 2000 Hamburg 4, FRG),
A. F. G. Fiuza and I. D. James

In the initial phase of MARSEN (Marine Remote Sensing Experiment) three main water masses and North Frisian Wadden Sea Water were found in the German Bight in the late summer of 1979. This is shown by t/S diagrams of the CTD data obtained with the RV "Friedrich Heincke" and the RRS "John Murray". For each t/S pair the percentage composition of the three main water masses is estimated by applying the linear mixing theory. The distribution of the main water masses indicates a frontal structure in the German Bight.
A clearly separated water mass, which originates from the mixing of North Sea bottom water and Elbe estuary water, is found in the frontal area. This frontal water is apparently trapped by the vertical current shear and the topography of the post-glacial valley of the Elbe.

J. Geophys. Res., Green, Paper 3C0061

4730 Internal Waves
VERTICAL DISPERSION OF INERTIAL WAVES IN THE UPPER OCEAN
D. M. Rubenstein (Ocean Physics Division, Science Applications, Inc., McLean, Virginia 22102)

A linear model of the vertical dispersion of near-inertial waves is developed. A porosity distribution near the bottom of the computational domain minimizes bottom reflections, and simulates an ocean of infinite depth. The model is used to show that the vertical dispersion of near-inertial waves in the upper ocean may, under certain conditions, contribute significantly to the observed rapid decay of inertial oscillations in the surface layer. The kinetic energy of inertial oscillations at midlatitudes decays with an e-folding time scale of 10 days or less, when the parameter λ(km)/N(cph)d(m) is less than or of order unity, where λ is the wavelength of the wind-generated near-inertial waves, N is the Väisälä frequency in the upper pycnocline, and d is the surface layer thickness.

At the top of the pycnocline the model predicts a velocity maximum, which develops as energy propagates downward, out of the surface layer. However, when the upper pycnocline is sufficiently peaked a resonant frequency interference effect is predicted. This effect modulates the dissipation of surface layer inertial oscillations, and their magnitude after a storm need not decay monotonically. We also make qualitative comparisons with deep-ocean current meter observations taken during MILE, and with shallow water (105 m) observations taken in the Baltic Sea. (Inertial oscillations, internal waves, upper ocean dynamics).

J. Geophys. Res., Green, Paper 3C0040

4760 Sea Ice
THE WIND-DRAG COEFFICIENT OVER FIRST-YEAR SEA ICE IN THE BERING SEA
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Profiles of relative wind speed and temperature were collected from four levels over rough sea ice in the marginal ice zone of the Bering Sea and used to compute surface wind drag coefficients. Based upon 138 profiles for near-constant ice conditions, northeast winds at 3-15 m s⁻¹, and near-neutral stability, the mean, near-neutral, 10-m drag coefficient was 0.00309 ± 0.00049. This is among the largest drag coefficients measured for neutral atmospheric conditions over sea ice. Sixty-five percent of the variance of this estimate is explained by orientation of the ice floe to the wind; an additional five percent of the variance is explained by wind-speed dependence. Provided that diabatic atmospheric stability over the Bering Sea ice pack is well correlated with low wind speed, the significant ice-advecting wind stress on the ice is determined from the neutral value of the drag coefficient, a function of ice roughness length alone. The ice forecaster thus may use remote measurements or estimates of wind speed and surface roughness to assess the wind component of ice advection. (Drag Coefficient, Sea Ice Advection, Air-Ice Interaction).

J. Geophys. Res., Green, Paper 2C1893

Oceanology
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4760 Sea Ice
EDGE WAVES AS A CAUSE OF ICE RIDE-UP ON SHORE
E. Mollo-Christensen (Department of Meteorology and Physical Oceanography, Massachusetts Institute of Technology, Cambridge, MA 02139)

Edge waves on ice covered water, generated where the wind can reach large amplitudes where bottom slope and current combine to give low group velocity. The amplitude of water velocity normal to shore can become large, and the resulting acceleration of the ice cover onto the shore may be sufficient to cause ice ride-up as has been observed. Edge waves on ice-covered ocean with a mean current is analyzed in a linear approximation, and estimates are given of velocities and amplitudes.

J. Geophys. Res., Green, Paper 3C0039

4765 Surface waves, tides, and sea level
ANALYSIS OF MARSEN X-BAND SAR OCEAN WAVE DATA
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Analysis of X-band SAR imagery collected during the MARSEN experiment indicates that the APD-10 SAR system imaged both range and azimuth-traveling gravity waves. However, only the near-edge portion of the APD-10 imagery provided reliable spectral wave estimates. Numerous motion artifacts, which manifest themselves as azimuth-oriented streaks, are visible on the data and are believed to be caused by breaking waves. Because of the large platform velocity, the APD-10 SAR data are relatively insensitive to wave enhancement adjustments performed during the processing of SAR signal histories. A modulation transfer function to relate SAR-derived spectra to *in situ* measurements has been developed. The transfer function is smaller and falls off more rapidly with wave number for azimuth-traveling waves than for range-traveling waves. This is a consequence of the smaller inherent modulation for azimuth-traveling waves and the degraded resolution in the azimuth direction due to motion effects, and agrees at least qualitatively with theoretical predictions.

J. Geophys. Res., Green, Paper 3C0078

4765 Surface waves, tides, and sea level
SEASAT SYNTHETIC APERTURE RADAR OBSERVATIONS OF WAVE-CURRENT AND WAVE-TOPOGRAPHIC INTERACTIONS
G.A. Meadows*, R.A. Shuchman, Y.C. Tseng*, and E.S. Kasischke (*Dept. of Atmospheric and Oceanic Science, University of Michigan, Ann Arbor, MI, 48109; Environmental Research Institute of Michigan, P.O. Box 8618, Ann Arbor, MI 48107).

This study investigated the capability of a space-borne, imaging radar system to detect subtle changes in the propagation characteristics of ocean wave systems. Specifically, an evolving surface gravity wave system, emanating from Hurricane Ella and propagating toward Cape Hatteras, North Carolina, formed the basis of this investigation. This wave system was successfully imaged by the Seasat Synthetic Aperture Radar (SAR) during Revolution 974 on 3 September 1978. Estimates of the dominant wavelength and direction of the ocean waves were derived from the SAR data using optical Fourier transforms. Environmental data of the test area, which included the surface velocity vector within the Gulf Stream, the location of Hurricane Ella, and local bathymetric information, were used in conjunction with the SAR data to form the basis of this comparative study. Favorable agreement was found between wave rays calculated utilizing theoretical wave-current and wave-topographic interactions and SAR observed dominant wavelength and direction changes across the Gulf Stream and continental shelf. (Seasat, Gulf Stream, wave-current interaction).

J. Geophys. Res., Green, Paper 2C1908

Particles and Fields—Interplanetary Space

5360 Solar wind interactions with moon and planets
CHARGE-EXCHANGE IN THE MAGNETOSHEATHS OF VENUS AND MARS: A COMPARISON
C. T. Russell (Institute of Geophysics and Planetary Physics, University of California, Los Angeles, California, 90024), T. I. Gombosi, M. Horanyi, T. E. Cravens and A. F. Nagy

The amount of solar wind absorption due to charge-exchange in the Martian magnetosheath is evaluated and found to be about an order of magnitude less than that in the Venus magnetosheath. This difference might explain the observed difference in the scaled position and shape between the shocks at Venus and Mars. The lower solar wind absorption for Mars is attributable to the less dense hot oxygen corona of Mars compared to Venus. (Venus, Mars, charge-exchange, solar wind, magnetosheath, atmosphere).

Geophys. Res. Lett., Paper 3L0015

5360 Solar wind interactions with moon and planets
GLOBAL CHARACTERISTICS OF MAGNETIC FLUX ROPES IN THE VENUS IONOSPHERE
R. C. Elphic (NAS/NRC Research Associate, NASA/Goddard Space Flight Center, Greenbelt, MD 20771), C. T. Russell

In this paper we examine the global characteristics of the magnetic flux ropes in the Venus ionosphere. These structures are the most common magnetic feature of the ionosphere, being observed on more than 70% of the orbits of the Pioneer Venus orbiter passing through the dayside ionosphere. The spatial occurrence of flux ropes maximizes at altitudes near 165 km; they may occupy more than 50% of the ionospheric volume at this altitude. At higher altitudes the fractional volume occupied by ropes decreases below 20%. Scale radii of the ropes vary between 6 km at 160 km altitude and 15 km at 500 km altitude, and scale roughly with both the local ion gyroradius and ion inertial length. Ropes above 200 km altitude in the low zenith angle (χ<45°) regions appear to have quasi-horizontal orientations, while those below 200 km altitude in the low zenith angle (χ<45°) cases tend to be horizontal above 300 km and randomly oriented below 300 km. Ropes may tend to be more tightly "twisted" at low altitudes than at high, and more so in the χ<45° regions than nearer the terminator. Rope field strengths are highest near the altitudes where their occurrence maximizes, i.e., near 165 km, and scale with the square root of the ambient thermal pressure. Finally, the global polarities of flux rope field-aligned currents appear to be random and do not clearly support a steady, nonturbulent global formation mechanism. (Venus, flux ropes, ionosphere).

J. Geophys. Res., Blue, Paper 3A0017

5380 (Solar wind plasma)
ON THE EQUATION OF STATE OF SOLAR WIND IONS DERIVED FROM HELIOS MEASUREMENTS
E. Marsch (Center for Space Research, Massachusetts Institute of Technology, Cambridge, MA 02139, USA), K. H. Mühlhäuser, R. Rosenbauer, R. Schwenn

Observations of solar wind ion velocity distributions made by the Helios spacecraft between 0.3 and 1 AU are used to study the radial evolution of the so-called adiabatic invariants, for example, the ion magnetic moments. Significant differences between the parameters of protons and α-particles have been found in dependence on the wind velocity. On the average, adiabaticity is observed to be violated. We interpret this violation of adiabatic invariance as evidence that protons are heated perpendicular to the field in fast streams and, with less statistical significance, that α-particles are cooled more strongly than for adiabatic expansion parallel to the magnetic field. The contribution of the differential streaming energy to the total internal energy of the ions is briefly investigated. Also average heliocentric radial profiles for the ion heat fluxes are presented and the possible role of the ion heat flux in suppling thermal energy during the radial expansion of the wind is examined. Our findings suggest that wave-particle interactions and (or) Coulomb collisions (or other yet unknown processes) have to be invoked in order to explain the thermal energy state of solar wind ions and their radial temperature profiles. (Ion equation of state, adiabatic invariants, ion heat flux).

J. Geophys. Res., Blue, Paper 2A1972

Particles and Fields—Ionosphere

5505 Particles and Fields – Ionosphere (Airglow)
THERMOSPHERIC ODD NITROGEN 2. COMPARISON OF ROCKET OBSERVATIONS WITH A DIFFUSIVE TRANSPORT CHEMICAL MODEL
R. P. McCoy (E. O. Hulburt Center for Space Research, Naval Research Laboratory, Washington, DC 20375)

A one-dimensional model of thermospheric odd nitrogen chemistry is used to simulate simultaneous rocket measurements of NO, $N(^4S)$ and $O(^3P)$ at twilight. Good agreement between the observations and the model is obtained for the $N(^4S)$ densities above 100 km and for the NO densities above 130 km. Differences between the $N(^4S)$ profiles from the upleg nightglow and downleg twilight airglow measurements are consistent with the diurnal variation of $N(^4S)$ predicted by the theory. The model shows that with high thermospheric temperatures the diurnal variation of NO decreases while the $N(^4S)$ diurnal variation increases. This behavior is attributed to the temperature sensitivity of the rate for the production of NO from $N(^4S)$ and O_2. The model is used to predict the solar cycle dependence of the NO chemiluminescence. (Airglow, Odd Nitrogen Chemical Model).

J. Geophys. Res., Blue, Paper 2A1854

5505 Particles and Fields – Ionosphere (Airglow)
THERMOSPHERIC ODD NITROGEN 1. NO, $N(^4S)$ AND $O(^3P)$ DENSITIES FROM ROCKET MEASUREMENTS OF THE NO δ AND γ BANDS AND THE O_2 HERZBERG I BANDS
R. P. McCoy (E. O. Hulburt Center for Space Research, Naval Research Laboratory, Washington, DC 20375)

Airglow emissions from the upper atmosphere were measured with instruments on a sounding rocket launched on November 7, 1979. The nitric oxide delta and gamma bands and the molecular oxygen Herzberg I bands were observed at evening twilight with a pair of ultraviolet spectrometers and a photometer. Nightglow emission of NO and O_2 were measured on the upleg. Twilight NO gamma band fluorescence and NO delta band chemiluminescence were measured on the downleg. The altitude profiles of the NO and O_2 nightglow emissions were inverted to yield the density of $O(^3P)$ between 90 and 120 km and the density of $N(^4S)$ between 100 and 200 km. The twilight NO gamma band emission profile was inverted to yield the density of nitric oxide between 112 and 200 km. By viewing in the solar and anti-solar directions on the two legs of the flight the measurements provide an indication of the temporal variation of the $N(^4S)$ density. These observations provide the first simultaneous measurements of the thermospheric densities of NO, $N(^4S)$ and $O(^3P)$. (Airglow, NO δ and γ Bands, O_2 Herzberg I Bands, Odd Nitrogen Density Measurements).

J. Geophys. Res., Blue, Paper 2A1853

5515 Auroras
OBSERVATIONS OF SMALL-SCALE AURORAL VORTICES BY THE S3-2 SATELLITE
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We have studied two intense auroral events which were encountered by the S3-2 satellite at ~ 0550 and ~ 1930 MLT, during a substorm, near the equatorward edge of the region 1 current system. The events are marked by large deflections in the east-west magnetic field component. In the dawn (dusk) event the deflection was 100 (300) nT with a total duration of 4(7) seconds. In both cases the deflection corresponding to an upward current sheet was sharpest, occuring over .25 seconds. Upward current strengths of 45 and 135 μA/m² within latitude extents of < 2 km are inferred. The principal region of return current is not continuous with the upward current sheet and is more spatially extended, with maximum intensities in the range of 10 to 15 μA/m². The events are associated with electric fields whose magnitude can exceed 200 mV/m. In the region between the current sheets, adjacent to the principal upward current sheet, the electric field rotated by 180° then returned to its original orientation. Such electric field variations give rise to plasma vortex flow patterns similar to those observed in auroral folds and curls. Despite spatial aliasing, the measurements of an electron detector in the vicinity of the upward current sheets provide useful information concerning the density and temperature of the parent populations and the fieldaligned potential drop. With some reasonable assumptions, it is shown that observed values of $J_\parallel$ and $\phi_\parallel$ are consistent with collisionless, single-particle theories. (Auroral arcs, field-aligned currents, electrostatic shocks, electric fields, auroral vortices)

J. Geophys. Res., Blue, Paper 2A1922

5520 Electric Fields
A TEST OF THE COSINE-RELATIONSHIP USING THREE-RADAR VELOCITY MEASUREMENTS
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Three coherent radars have been used to obtain simultaneous radial Doppler velocity measurements in three directions from a common volume in the E-layer of the high latitude ionosphere. The cosine-relationship, which were derived in the fluid approximation of the plasma instabilities associated with radar aurora, provides a consistent framework in which to interprete radial Doppler velocity observations. However, a systematic discrepancy of the observed radial velocities and the cosine-relationship is found and discussed. For observations in the eastward electrojet this discrepancy is qualitatively on line with expectations based on the kinetic theory of the instabilities. It appears that the possible phase velocities in the plasma are limited to lower values than previously thought. This implies that an estimate of the electron drift velocity obtained using the fluid approximation at times may represent an underestimate of the actual electron drift velocity. (plasma instabilities, electric field).

Rad. Sci., Paper 3S0030

5920 Electric Fields
VARIABILITY OF THE HARANG DISCONTINUITY AS OBSERVED BY THE CHATANIKA RADAR AND THE IMS ALASKA MAGNETOMETER CHAIN
Y. Kamide (NOAA Space Environment Laboratory, 325 Broadway, Boulder, CO 80303)

The relative location of ionospheric parameters and ground magnetic perturbations in the vicinity of the Harang discontinuity is examined. For this purpose, we use combined observations of the Chatanika incoherent scatter radar and of the IMS Alaska meridian chain of magnetometers, which were continuously measuring the crucial ionospheric parameters near the Harang discontinuity when a sizeable substorm took place. The Harang discontinuity, as defined by the reversal of the north-south electric field, is found to be located at 1-2° poleward of the discontinuity identified by the conventional method of using ground magnetic perturbations. It is also found that the relative location of auroral conductivity enhancements is quite variable, depending perhaps upon substorm time. During relatively quiet times and the early stage of a substorm, a conductivity enhancement occurs only on the poleward side of the Harang discontinuity defined by the electric field reversal, whereas the enhancement surges equatorward extending beyond the discontinuity during the maximum to recovery phase of a substorm. (Harang discontinuity, ionospheric current, electric field, radar observations).

Geophys. Res. Lett., Paper 3L0104

5530 High-latitude Ionospheric Currents
A DYNAMIC MODEL FOR THE AURORAL FIELD LINE PLASMA IN THE PRESENCE OF FIELD-ALIGNED CURRENT
H.G. Mitchell, Jr. (Science Applications, Inc., McLean, Virginia 22102) and P.J. Palmadesso (Naval Research Laboratory, Washington, D.C. 20375)

We have developed a dynamic numerical model of the plasma along an auroral field line in order to provide a vehicle for studying ionosphere – magnetosphere coupling processes. The model is a multi-moment multi-fluid approximation of a gyrotropic plasma consisting of three species (electrons, hydrogen ions, oxygen ions) along a segment of auroral magnetic field line extending from an altitude of 800 km to 10 earth radii. We have performed simulations for the case of a current-free polar wind equilibrium of the field line plasma and the case in which a large upward field-aligned current is applied to the field line. In the former case, the agreement between our model and previous static results is reasonable given the differing boundary boundary conditions inherent in the two cases. In the case of a field-aligned current, we note that the flux tube plasma responds to the current on several time scales. After an initial rapid heating of the electrons due to precipitation in a converging magnetic field, electric field coupling of the electrons to the ions causes thermal oscillations of the flux tube plasma to persist on time scales of the order of one hour, illustrating the complicated nature of the response of a collisionless plasma when heat flow transport is treated in a dynamic manner. (Field-aligned current, polar wind, magnetosphere-ionosphere coupling)

J. Geophys. Res., Blue, Paper 3C0001

5535 Interaction between waves and particles
PREFERENTIAL PERPENDICULAR ACCELERATION OF HEAVY IONOSPHERIC IONS BY INTERACTIONS WITH ELECTROSTATIC HYDROGEN CYCLOTRON WAVES
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The energization of heavy ionospheric ions by Electrostatic Hydrogen Cyclotron (EHC) waves is examined. In particular, the problem of preferential perpendicular acceleration of heavy ions above 5000 km along auroral field lines is examined critically. Observations have indicated that above this altitude the occurrences of ion beams and EHC waves are highly correlated and that the occurrence rates are high. The EHC waves are found to be coherent. The energization process is examined in the light of interactions of a single coherent wave with the ions. The interactions can be stochastic or nonstochastic, depending on the parameters of the wave and of the background H^+ ions supporting the wave. With electric field wave amplitudes of a few tens of millivolt/m, it is shown that the interaction can give perpendicular energies of the order of keV for O^+ ions. He^+ ions are shown to gain perpendicular energies smaller than O^+ ions. It is indicated that upward flowing H^+ ions cannot gain any appreciable amount of perpendicular energy. For a given electric field wave amplitude E_0, the extent of energization critically depends on the average perpendicular energy (temperature) $W_{\perp H}$ of the background H^+ ion plasma. Examples are worked out for values of $W_{\perp H}$ ranging from 1 to 200 eV. The resulting energizations and pitch angles for O^+ and He^+ ions are compared with observations from satellites. The heating times for the ions are found to be of the order of 2 seconds at an altitude of 5000 km.

J. Geophys. Res., Blue, Paper 3A0112

5545 Ionospheric disturbances
NIGHTTIME VHF AND GHZ SCINTILLATIONS IN THE EAST-ASIAN SECTOR OF THE EQUATORIAL ANOMALY
A. W. Wernik (Department of Electrical Engineering, University of Illinois, Urbana-Champaign, Illinois, 61801), S. Franke, C. H. Liu and D. J. Fang.

Measurements made during solar maximum years in the East Asian sector of the equatorial anomaly show different seasonal patterns of night-time scintillation occurrence at 137 MHz at Lunping and 4 GHz at Hong Kong. These seasonal variations are very similar to that observed at the equatorial station in Guam, indicating strong coupling between equatorial and anomaly irregularities. Model computations indicate that the GHz scintillation observed at Hong Kong is much stronger than one would expect based on VHF scintillation measured at Lunping. It is suggested that this might be an indication of strong latitudinal dependence of scintillation in the anomaly region. We also discuss the possible difference in local ionospheric conditions that were responsible for generating GHz scintillation causing irregularities in the anomaly region and at the equator. (Ionospheric disturbance, radio wave propagation).

Geophys. Res. Lett., Paper 3L0059

5560 Particle Precipitation
THE EFFECTS OF ENERGETIC PARTICLE PRECIPITATION ON THE ATMOSPHERIC ELECTRIC CIRCUIT
I. B. Rengan, R. E. Hevorott, J. E. Evans, and W. L. Imhof (Lockheed Palo Alto Research Laboratory, Palo Alto, California, 94304), R. G. Joiner (Office of Naval Research)

The solar particle event (SPE) of August 1972 is one of the largest that has occurred in the last 20 years and can serve as a good example of a major perturbation to the atmospheric electric system. In this paper ion production rates and conductivities from the ground to 80 km at the peak intensity of the event on 4 August and for 30, 35, and 40 km for the 6-day duration of the event are presented. At the peak of the event, the proton and electron precipitation currents, the ohmic current, and the vertical electric field are calculated inside the polar cap. The particle precipitation currents at this time greatly exceed the normal air earth current at altitudes above 30 km and produce reversals in the vertical electric field at 28 km and above. Calculations are presented of the vertical electric field at altitudes near 30 km where balloon measurements were made. Good agreement between the calculated and the measured vertical electric field verifies our ability to calculate disturbed conductivities at these altitudes from satellite measurements of proton spectra incident on the atmosphere. Despite the fact that at the peak of the event the vertical electric field near 30 km was shorted out by the solar particles and that the current carried by the solar particles exceeded the fair weather air-earth current density in the stratosphere by large factors it is concluded that the largest effect of an SPE of this magnitude on the atmospheric electric circuit is due to the Forbush decrease in the galactic cosmic ray flux rather than to the large increase in solar proton flux. (Particle precipitation, particle currents, atmospheric conductivity, cosmic ray ionization).

J. Geophys. Res., Green, Paper 3C0005

5563 Plasma motion, convection or circulation
MONTE CARLO CALCULATIONS OF THE O^+ VELOCITY DISTRIBUTION IN THE AURORAL IONOSPHERE
A. R. Barakat (Center for Atmospheric and Space Sciences, Utah State University, Logan, Utah 84322), R. W. Schunk and J.-P. St.-Maurice

The O^+ velocity distribution in the high-latitude F-region has been calculated using a Monte Carlo technique. The calculations were restricted to the altitudes where O^+-O collisions dominate, i.e., between about 200-350 km. The Monte Carlo calculations confirm the earlier predictions, which were based on a simple relaxation collision model, that the O^+ velocity distribution takes a toroidal shape for large convection electric fields. However, the toroidal features appear only for electric fields greater than about 80-100 mV/m when a more rigorous ion-neutral collision model is used, whereas the relaxation collision model predicted toroidal features for electric fields greater than about 40 mV/m. Since a toroidal velocity distribution is unstable, ionospheric irregularities can be expected at altitudes between 200-350 km when the convection electric field exceeds 80-100 mV/m.

J. Geophys. Res., Blue, Paper 3A0107

5580 Wave Propagation
A MORPHOLOGICAL STUDY OF GIGAHERTZ EQUATORIAL SCINTILLATIONS IN THE ASIAN REGION
D. J. Fang (COMSAT Laboratories, Clarksburg, Maryland, 20871) and C. H. Liu

Concerted efforts were made from 1978 to 1980 to monitor ionospheric scintillations in the Asian region. Two geostationary satellites (INTELSAT IV F8, Pacific Ocean Region, and INTELSAT IV-A F1, Indian Ocean Region) and five earth stations (Hong Kong, Singapore, Thailand, Hawaii, and Sri Lanka) with a total of eight up/down-link signals at 4 and 6 GHz, respectively, were involved. Twenty-nine months of 4-GHz data received at the Hong Kong Earth Station were used for analysis. This measurement period coincided with the solar maximum period of the current solar cycle 21. Scintillations of severe intensity with peak-to-peak fluctuations of up to 14 dB were recorded. This paper examines the morphological aspect of scintillations in the Asian region, including the equinoctial occurrence pattern, diurnal onset characteristics, relationship between scintillations along the eastward and westward links during sunset, and correlation with sunspot numbers. These findings, complementary to information already available from American and European-African regions, provide an essential element in understanding the global behavior of gigahertz ionospheric scintillations. (Ionospheric scintillation, 4-GHz beacon, solar cycle).

Rad. Sci., Paper 2S1982

5580 Wave propagation
QUANTITATIVE STUDY OF SUBSTORM-ASSOCIATED VLF PHASE ANOMALIES AND PRECIPITATING ENERGETIC ELECTRONS ON NOVEMBER 13TH 1979
T. Kikuchi (Radio Research Laboratories, Koganei, Tokyo 184, Japan) and D. S. Evans

Phase anomalies associated with magnetospheric substorms were observed on VLF signals propagating on transauroral paths (GBR, OMEGA-ALDRA and OMEGA-N.DAKOTA – Inubo Japan) during the events on November 13th, 1979. Detailed comparisons are made between these VLF phase anomalies and geomagnetic bays, and quantitative relations are obtained with precipitating energetic electrons (E > 30, > 100 and > 300 keV) detected onboard the TIROS-N and NOAA-6 satellites. It is found that two types of VLF phase anomalies exist which in turn are associated with two phases in the history of energetic electron precipitation into the atmosphere. The first type of phase anomaly is associated with direct injection of energetic electrons into the outer magnetosphere and atmosphere which is completely correlated in time with development of the auroral electrojet current system. The second type arises from energetic electrons which subsequently precipitate from a trapped electron population and has a delayed onset and prolonged duration.

Excellent quantitative correlations are obtained between the energetic electron fluxes and the magnitude of the phase anomaly on the OMEGA-ALDRA signal. From the local time characteristics of the quantitative relations, it is concluded that the electrons with E > 300 keV are the main source of D-region ionization responsible for the VLF phase anomaly even during the night. (VLF phase, substorm, precipitating energetic electrons).

J. Geophys. Res., Blue, Paper 2A1007

5585
NEUTRON HIGH ENERGY SPECTRA AT 7 DIFFERENT DEPTHS IN THE ATMOSPHERE FROM 0 TO 40 MBAR NEAR THE GEOMAGNETIC EQUATOR.
V.L.BHATT (Physical Research Laboratory, Ahmedabad 380 009/India).

Atmospheric neutrons 8 to 200 MeV are studied. Neutron differential energy spectra and integrated spectra at 0, 4, 6, 10 and 40 mbar are given. Spectra for E > 50 MeV are given for 7 different altitudes. All spectra show maxima near 40 MeV and large drops near 22 and 100 MeV confirming clear structures. Our results at λ = 7.8°N are compared with others near λ = 42°N both theoretical and experimental. Explanations are offered for the important features and the actual shape of the neutron energy spectra.(Atmospheric neutron energy spectra).

J. Geophys. Res., Blue, Paper 2A1838

5599 General (Ionospheric Modification)
OBSERVATIONS OF THE HF-ENHANCED PLASMA LINE WITH A 46.8 MHz RADAR AND REINTERPRETATION OF PREVIOUS OBSERVATIONS WITH THE 430 MHz RADAR
J.A. Fejer (Max-Planck-Institut für Aeronomie, 3411 Katlenburg-Lindau 3, F.R.G., now at Arecibo Observatory, Arecibo, Puerto Rico 00613), H.H. Ierkic, R.F. Woodman, J. Röttger, M. Sulzer, R.A. Behnke and A. Veldhuis

During 5.1 MHz HF transmissions below the F-region penetration frequency by a nearby ionospheric modification facility, radar echoes coming from F-region heights at a frequency of 46.8 + 5.1 = 51.9 MHz were received while a VHF radar using the 305 m spherical reflector at Arecibo was transmitting pulses coherently on 46.8 MHz. The bandwidth of the echoes was less than 10 Hz. The so-called decay line due to the parametric decay instability was expected at a frequency lower by about 300 Hz but it was not observed. Density variations caused by the ponderomotive force resulting from the standing wave pattern at 5.1 MHz are tentatively invoked to explain the observations. Poorly understood aspects of some previous observations with the 430 MHz radar can be similarly explained. (Ionospheric modification, parametric instabilities)

J. Geophys. Res., Blue, Paper 2A1930

5599 General (Spacecraft Optical Glow)
VISIBLE GLOW INDUCED BY SPACECRAFT-ENVIRONMENT INTERACTION
J.H. Yee (Harvard-Smithsonian Center for Astrophysics, 60 Garden Street, Cambridge, MA 02138), and V.J. Abreu

Illumination was found recently in the ram direction of the Shuttle Orbiter arising from interaction with the ambient surrounding atmosphere. We have examined a similar optical glow by analyzing photometric data taken by the Visible Airglow Experiment on board the Atmosphere Explorer Satellites. Analysis at six different wavelengths from the ultraviolet to the near infrared suggests that the glow has a diffuse band or continuum spectrum which peaks in the red and probably in the infrared.

Geophys. Res. Lett., Paper 3L0094

Particles and Fields—Magnetosphere

5705 Bow Shock Waves
STABILITY OF ELECTRON DISTRIBUTIONS WITHIN THE EARTH'S BOW SHOCK
M. F. Thomsen (MS D438, Los Alamos National Laboratory, Los Alamos, NM 87545), H. C. Barr, S. P. Gary, W. C. Feldman, and T. E. Cole

The linear Vlasov stability of a class of electron velocity distributions which model those observed within the earth's bow shock is examined. The study is restricted to electrostatic waves which propagate parallel to the ambient magnetic field, B. Two instabilities are identified which are driven by free energy in the direction parallel to B: An ion acoustic wave, with real frequency below the ion plasma frequency; and an electron acoustic wave, with real frequency of several times the ion plasma frequency. The characteristics of the unstable waves are in accord with observations obtained within the bow shock, in particular with the trend of the observed electrostatic waves to be polarized parallel to the magnetic field. The instabilities identified here may contribute to electron dissipation in collisionless shocks. (Collisionless shocks, electron distributions, instabilities).

J. Geophys. Res., Blue, Paper 3A0113

5716 Electric Fields
OBSERVATIONS OF LARGE MAGNETOSPHERIC ELECTRIC FIELDS DURING THE ONSET PHASE OF A SUBSTORM
T. L. Aggson (NASA/Goddard Space Flight Center, Laboratory for Extraterrestrial Physics, Greenbelt, Maryland, 20771), J. P. Heppner and N. C. Maynard

A large (30 mV/m peak) impulsive westward electric field was observed in the midnight, low latitude, dipole L = 7.6 region of the earth's magnetospheric tail at the onset of a large substorm. The measurements were made with the long, 179 m baseline, cylindrical electric field probes carried by ISEE-1. The electric field impulse was coincident with a sharp 60 nT step-like change in the x-component of the magnetic field at the satellite and the onset of a sharp 600 nT decrease in the H component of the field at a magnetic observatory near the subconjugate point. The 2 minute envelope of the westward, E_y, field correlates with the time derivative, $\partial B_x/\partial t$, of the collapsing magnetic field attributed to the decrease in the cross-tail current. Associated with this inductive impulse, large electric field variations are also observed on time scales of tens of seconds to tens of milliseconds. The low frequency (10 seconds) wave variations show a coherent phase relationship between the electric and magnetic field which changes from correlative to anti-correlative during the event. Higher frequency (t < 1 s) turbulent electrostatic fields of similar magnitude are present throughout the event. These large time dependent electric fields seem to have the proper amplitude, duration, and timing relative to the auroral substorm sequence to explain the energetic proton enhancements frequently observed near midnight both at synchronous orbit and in the magnetotail at times of substorm onsets. The azimuthal direction of E_y (westward) for this event appears to conflict with the IMP-6 observations of an eastward E_y at higher latitudes under similar conditions. However, these observations are in agreement when magnetotail collapse is viewed in terms of a sharp reduction in the anti-solar tension on auroral field lines as opposed to interpretations based solely on the effects of a sudden decrease in the cross-tail current sheet.

J. Geophys. Res., Blue, Paper 2A0981

5715 Electric fields
NUMERICALLY SIMULATED TWO-DIMENSIONAL AURORAL DOUBLE LAYERS
Joseph E. Borovsky (Department of Physics and Astronomy, University of Iowa, Iowa City, Iowa 52242) and Glenn Joyce

Electrostatic plasma double layers are numerically simulated using a magnetized 2 1/2-dimensional particle-in-cell system, periodic in one direction and bounded by reservoirs of Maxwellian plasma in the other. The simulations of both oblique and two-dimensional double layers show periodic instability, indicate Debye-length rather than gyroradii scaling, and reveal low-frequency electrostatic turbulence and electron-beam excited electrostatic electron-cyclotron waves. Simulated electric-field and electron-beam data resemble referenced satellite measurements of oppositely directed electric fields within auroral regions and of precipitating electrons in inverted-v events. Estimates are given for the thicknesses of auroral double layers and for the separations within multiple auroral arcs. The temporal modulation of accelerated beams is investigated; the possibilities of the double-layer production of ion conics and of ion precipitation are hypothesized; and the consequences of electrostatic plasma-wave excitement is discussed. Simulations including the atmospheric backscattering of electrons predict the presence of an ionospheric sheath which acts to accelerate ionospheric ions upward. (Electric fields, auroras, particle precipitation, double layers).

J. Geophys. Res., Blue, Paper 3A0108

5515, 5520, 5560

5755 Plasma Instabilities
GENERATION OF LOWER HYBRID WAVES BY INHOMOGENEOUS ELECTRON STREAMS
M.J. Keskinen (Naval Research Laboratory, Washington, D.C. 20375) and J.D. Huba

A linear, electrostatic, kinetic theory of velocity sheared inhomogeneous electron streams flowing parallel to a magnetic field is presented. Our development, which includes the effects of a density gradient, background plasma, and electron collisions, is valid for arbitrary T_{es}/T_i and T_{eb}/T_i where T_{es}, T_{eb}, T_i are the temperatures of the sheared electrons, background electrons, and background ions, respectively. For hot electron streams $T_{es}/T_i >> 1$ and $T_{es} >> T_{eb}$, we find a new resonant instability driven by velocity shear with frequency near the lower hybrid frequency. This mode is characterized by wavenumbers k such that $kr_{Les} \lesssim 1$ where r_{Les} is the sheared electron gyroradius and is damped by collisional effects. Application is made to wave turbulence in the auroral zone and solar corona.

J. Geophys. Res., Blue, Paper 3A0111

5775 Trapped Particles
THE ADIABATIC MOTION OF CHARGED DUST GRAINS IN ROTATING MAGNETOSPHERES
T. G. Northrop (Laboratory for High Energy Astrophysics, NASA/Goddard Space Flight Center, Greenbelt, MD 20771), J. R. Hill

Dust grains in the ring systems and rapidly rotating magnetospheres of the outer planets such as Jupiter and Saturn may be sufficiently charged that the magnetic and electric forces on them are comparable with the gravitational force. The adiabatic theory of charged particle motion has previously been applied to electrons and atomic size particles. But it is also applicable to these charged dust grains in the micrometer and smaller size range. We derive here the guiding center equation of motion, drift velocity, and parallel equation of motion for these grains in a rotating magnetosphere. The effects of periodic grain charge-discharge have not been treated previously and have been included in this analysis. Grain charge is affected by the surrounding plasma properties and by the grain-plasma velocity (among other factors), both of which may vary over the gyro-circle. The resulting charge-discharge process at the gyrofrequency destroys the invariance of the magnetic moment and causes a grain to move radially. The magnetic moment may increase or decrease, depending on the gyrophase of the charge variation. If it decreases, the motion is always towards synchronous radius for an equatorial grain. But the orbit becomes circular before the grain reaches synchronous radius, a conclusion that follows from an exact constant of the motion. This circularization can be viewed as a consequence of the gradual reduction in the magnetic moment. This circularization also suggests that dust grains leaving Io could not reach the region of the Jovian ring, but several effects could change that conclusion. Excellent qualitative and quantitative agreement is obtained between adiabatic theory and detailed numerical orbit integrations. (Charged Dust)

J. Geophys. Res., Blue, Paper 2A1705

Planetology

6525 Gross properties of the Moon (Magnetic paleointensity)
A REVIEW OF LUNAR PALEOINTENSITY DATA, AND IMPLICATIONS FOR THE ORIGIN OF LUNAR MAGNETISM
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The saturation remanence normalization method of paleointensity estimation has been applied to more than 50 lunar samples, and has been calibrated in terms of standard intensity determinations done on 14 samples. These results suggest that a lunar surface field, comparable in intensity to the Earth's magnetic field, existed from about 3.6 to 3.8 AE. Absolute paleointensity estimates and lunar surface field strength determinations are consistent with this observation. The data presented here differ from previous descriptions of the variation in the lunar field with time in that A) the oldest samples (>3.8 AE) are amongst the most weakly magnetized; B) an order of magnitude drop in paleointensity is suggested between the time of extrusion of the Apollo 11 low and high potassium basalts. The limited range in age of the strongly magnetized lunar samples and the absence of shocked samples in this set argues against a solar source for the lunar paleofield or for fields arising from transient phenomena such as impacts. The coincidence of this high field era with the termination of basin forming impacts and the beginning of mare basalt extrusion suggests a common cause. A close approach of the Moon to the Earth at about 3.8 AE may account for all three phenomena. The confined duration of the strong lunar field may allow for the assignment of relative ages for certain lunar samples and lunar surface features. (Lunar, paleointensity, magnetic fields).

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COMMENT ON 'A SCHEMATIC MODEL OF CRATER MODIFICATION BY GRAVITY' by H. J. Melosh
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Melosh's theoretical model for the collapse of large impact craters is based partly on inconsistent or ambiguously reported observations. His paper presents a table of data that describe the onset of complex morphologic features in craters on Mercury, earth, the moon, Mars, Ganymede, and Callisto. Melosh's onset diameters contradict the well-established observation that central peaks appear in smaller craters than do rim terraces. Additionally, the geometric relation of his model's collapsing transient cavity to the observed crater landform is unclear.

This note discusses various problems with descriptive morphologic data for impact craters and presents a revised table of onset diameters for peaks, terraces, pitted peaks, and peak rings on the six planets and satellites. The intent is to clarify some of the issues raised by Melosh's work and to help establish a more consistent body of observations. Finally, a qualitative model for the transient cavity of large impact craters attempts to reconcile some of the morphologic observations with Melosh's theory.

The transient cavity proposed here has a geometrically evolving form adapted from impact cratering experiments and geologic field observations of complex terrestrial meteorite craters. According to this scheme the deep inner bowl formed immediately after impact develops into a shallow outer dish later in the event. Early collapse of the inner bowl produces the central peak, whereas subsequent faulting at the edge of the outer dish yields the observed rim terraces.

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